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EDUCATIONAL PSYCHOLOGY

BY
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To

MARY FLORENCE JORDAN
MY MOTHER

and

CARRIE NICHOLSON JORDAN
MY WIFE

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PREFACE

In preparing this text the author has ever kept in mind the use to which its material is to be put. For this reason, on numerous occasions illustrations and clarifying evidence have been selected from studies of children in the schoolroom situation despite the fact that their findings have not been as clear-cut nor their results so conclusive as experiments from the animal world. After all, in only a few instances is it possible to apply directly knowledge gained in studying animals to the study of children.

The author has no apology to make for the rather large amount of statistical material introduced into the text. Any serious study of the subject inevitably encounters statistical tables which are to be interpreted. It is thus of the utmost importance that students develop in this course a methodology of statistical interpretation which will remain long after the material of the book has become obsolete. The same reasoning is sufficient to justify the introduction of an elementary chapter on statistics. If students have mastered this material before entering upon this class, well and good, it can be omitted. If they have not this statistical knowledge, the author in ten years' experience in teaching the subject has found that procedure into the study of individual differences is utter folly. Some attention to mental hygiene and to the problems of backwardness and their relation to matters of conduct seems amply justified in the light both of the present conditions of young people and the bearing of these two topics on the problems of school discipline. The chapter on the elementary school subjects is intended as illustrative material and to aid in fixing by interesting practice the principles of learning. The author hopes that the exercises appearing at the end of the chapters as well as the rather full lists of references will be of direct value both to the student and to the instructor.

My obligations are heavy. Heaviest of all are they to my teachers, E. L. Thorndike, R. S. Woodworth, and C. H. Judd. Much of what they have written has become the current coin of this text. Only those who have attempted to assemble the material around certain topics of educational psychology can know under what obligations this discipline is to Professor E. L. Thorndike. There is hardly a topic which would not be much the poorer without his contributions. My thanks are also due to my wife, Carrie Nicholson Jordan, who has made many valuable suggestions concerning the material and form of the book. She has read all the proof. Mr. E. H. Garinger who has used a mimeographed copy of the text in summer school classes has given me the benefit of many practical suggestions concerning the applicability of the illustrations to classroom conditions. Dr. H. B. Reed read critically the division concerned with learning. Several of his suggestions were embodied in the text.

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PART I

PROBLEMS INVOLVED IN LEARNING THE SCHOOL SUBJECTS

CHAPTER I

AN INTRODUCTION

Educational psychology deals with all phases of mental growth—learning, emotions, desires, etc. It does not assume to determine the final aims or ends of education, which is philosophy's function, but given the ends, it seeks to develop the method of attaining them in the most efficient manner. From the standpoint of the school this subject is the study of method. From the standpoint of psychology it is a concentrating of all knowledge of mental life upon the activities of the growing child, particularly as he goes and comes within the environment of the school. But method we should not conceive narrowly, for it includes not only the arrangement of the material of instruction, but also the selection of the materials themselves. These, too, must be determined by psychological principles. A good problem in arithmetic must both illustrate the mathematical principle involved and must fall within the experience of the child. Moreover, it must not be beyond the mental level of the pupil or else it fails of its purpose. It gains in value in proportion as it grows directly out of the child's experience. The study of the mental processes involved in learning includes a study of the inherited traits, the native characteristics appearing at birth and later; the effect of the surroundings upon these inherited characteristics; and the individual differences resulting from the interaction of inherited nature and environment.

PROBLEMS IN THE SCHOOLROOM TO BE SOLVED BY EDUCATIONAL PSYCHOLOGY

Numerous problems of a psychological nature are constantly presented to the teacher in the pursuit of his daily duties. Attention is one of the problems which plays an important rôle in the schoolroom. How best shall it be gained? Is it attained through the avenue of strict discipline which plays upon one of the strongest drives in human nature, fear, or by means of the introduction of material which is inherently interesting and significant? How far is it advisable to use sharp contrast and moving objects in attracting attention, and once attracted, what devices can be used to hold it on the material desired? Most important of all, how can an abiding interest in the subject matter be stimulated? For, after all, unless a child in his post-school life continues to read good books and to pay attention to worth-while things, most of the results attained in school will be wasted. In brief, what is there that catches and holds attention of young people which, for example, stimulates them to stand in line for an hour at a public library in order to obtain a favorite book, or else impels them to work for hours and hours at a radio? Dovetailing with this matter of attention is that of discipline. "Being bad" in school is for the most part attending to objects and movements considered undesirable. On the positive side, how can we build up useful habits which function in such a manner that discipline will no longer be a problem? In addition to these subjects of attention and discipline there are those relating to the arrangement of subject matter.

There are always many more facts to be learned than can possibly be learned. Which of these shall we put in the curriculum? How shall the facts be presented so that the meaning will always appear, and that the pupils will not have to learn by heart anything which is not understood? How well should the material be learned? What principles shall guide us in selecting material significant to the child? In attacking a course in general science shall there be a systematic textbook presentation, or shall there be, by means of laboratory experiments and observations, an unraveling of meaning of the objects and forces around us, such as the study of the gas engine or of the air? In discussing these matters the very nature of the learning process itself must be disclosed. What differences are there between learning reading and learning arithmetic? How does the curve of learning of one compare with that of the other? Again, the matter of systematic reviews is one of very great importance. Just how should they be distributed? Should there be frequent reviews immediately after the material has been learned, and should they be placed further and further apart as time goes on or indeed what is the best arrangement? With such problems as these must the teacher wrestle and educational psychology fails in its usefulness if it does not throw a clear light upon them.

Along with these problems of attention, discipline, and arrangement of material within a special subject, appears also one of individual differences. Individuals differ among themselves largely on account of their native capacities and of their environment. Children of the same age, say ten, may vary in the knowledge of any school subject, from second or third grade ability and lower, to seventh or eighth grade ability and even higher. We have unfortunately assumed in our school work that classification by age is about the only correct way. When objective measurements of children's performances arrived, one of its most surprising discoveries was the great differences between individuals of the same grade or of the same age. Think of trying to instruct a fifth grade class in arithmetic when two of the pupils could get right only two examples of adding nine three-place numbers in eight minutes, while another could do seventeen. This case, a real one, may be matched by the ability of a fourth grade in intelligence, for in this grade which the writer tested, individuals, as measured by the National Intelligence Tests, scattered all the way from about second grade ability to eighth grade ability. What shall we do, then, with individuals in a grade who are so much more capable than their mates? If we keep them there, we are partners to the crime of developing habits of idleness or lazy attitudes engendered by getting results without working for them; and if we promote them, we place them with boys and girls physiologically much more mature. Which is best and what does a child miss by being deprived of the comradeship of those of the same age?

With a few of the actual problems which teachers face before us, it seems clear that educational psychology attempts to focus on the school situation knowledge gained from any psychological source whatsoever. It deals with all phases of the growing child—his learning, his emotions, his desires and ambitions, in brief, his total personality—and all of these must be considered in relation to the school situation. Knowledge of the school child and his learning has been accumulating for a very long time. In the following paragraphs we shall attempt to show how the transition from anecdotal, untrustworthy knowledge has been effected. The gradual development of the scientific method in the study of school children has been largely responsible for this change.

METHODS OF COLLECTING DATA

1. The Anecdotal. As long as there have been teachers there must have been discussions about the personality of Mary or the stubbornness of Jim, and from such observations there has grown up a body of knowledge based on the anecdotal method. Experience itself has shown the unwisdom of some of these observations and the wisdom of others; but yet there remains a great deal of knowledge presented in books on method with nothing more substantial behind it than personal impression. Now this latter is untrustworthy. It has been proved that professional men make from 5 to 50 per cent of errors in reporting the events of a short, staged quarrel in which the events had been carefully rehearsed. This is the more surprising because they thought the events

real, and were submitting their reports as evidence before a court of law. Information based on observation, then, is notably inadequate, because it is biased by the peculiar bent of the observer, because of the rapidity with which the events are presented, and because careful records are not kept, so that in recalling events those facts opposing the main idea may be soon forgotten. Careful scientific men always make records, particularly of those results which are contrary to the leading hypothesis. We must at least do as much for educational psychology as Thorndike did for animal psychology, i. e., lift it out of the anecdotal stage.

II. The Questionnaire. The method of the questionnaire is somewhat more accurate and precise than the anecdotal, and marks one step upward on the road to scientific accuracy. This method consists of carefully formulating questions to be sent out to a large number of individuals in the hope that all of the questions will be answered by each person addressed. In most cases a certain percentage only of those that were sent out is returned. From these limited returns inferences are drawn. Then too, due to the poor coöperation of the persons questioned, and their lack of desire to tell the truth, errors may creep in. The value of the questionnaire, then, improves in proportion as those addressed answer the questions and in so far as they coöperate to the best of their ability. If individuals fail to answer the questions, careful record may be made of that fact.

An illustration of the use of the questionnaire appears in the writer's study of children's interests in books and magazines. In this investigation a large number of children were asked the following questions in an effort to discover what books and magazines boys and girls actually like:

(1) Will you kindly write down for me the name of the book you like best of all the books you have ever read?

(2) Now will you write down for me the name of the book you like next best of all the books you have ever read?

(3) Will you write down for me the name of the book you like next best and next best of all the books you have ever read until you have written the names of five books arranged in the order of your preference?

Similar questions were asked about their preferences for magazines. The children were asked to write down their first names only and to print their answers. The results were checked by observing what children read in a public library when they were left to their own devices. As a final check, recourse was had to a repetition after six months of questions previously asked. The same children who were questioned at first were also questioned the second time. The outcome of the two tests was remarkably similar. Even when nine years later the same questions were repeated to high school pupils of two other cities, nearly corresponding results were obtained, although some of the books formerly so popular had been discarded for those of a more recent vintage. Thus it appears that, when the questions are sufficiently simple and all of those questioned answer, the method is reliable enough for ordinary purposes. In general, if about 75 per cent of those questioned, answer, the results may be considered fairly reliable if they are internally consistent and may be checked by some other method. If fewer than 75 per cent reply to the questionnaire, the results are most certainly in doubt. There are, of course, ways of checking up the results when the percentage of replies is smaller than 75. One might try to discover if any particular group failed to reply. Were they composed of individuals who had a bent against this particular problem? And those answering, what of them? Are they particularly interested and hence somewhat biased? In spite of these limitations the questionnaire represents a distinct advance over the anecdotal method, because it does record, and it does get a variety of opinions.

III. The Experimental Method, A. The experimental method marks the summit of our scientific road in precision, accuracy, and reliability. It attempts above all other things to control the conditions, all of them, and to vary one known factor, carefully recording the consequences of its variation. The experiment is repeated enough times to satisfy the experimenter of the validity of his results, and careful record is made of the results so that they may be studied at leisure. Numerous devices, such as photographs and revolving drums covered with smoked paper to record the tiny movements of a lever, are used to make the records more stable. Finally, careful provision is made for repetition of the experiment by others—such as the exact description of the apparatus, pictures of its most intricate parts, and a detailed account of results. In the fields of the social sciences there is also some statistical treatment of the results to simplify them and to make sure of their reliability.

Perhaps an illustration drawn from the field of educational psychology will make clear just what is meant. In this experiment (Buswell's), which is merely summarized here, thereby omitting the rich details of the truly scientific method, it was purposed to discover the number and length of eye pauses per line in reading a simple passage. The ability of the readers varied all the way from that of the first grade to that of university students. (In the process of reading, the eye makes a series of fixations in each line during which words or parts of words are seen.) Average children from each grade were selected and, except for the first grade, the same material for reading was used throughout the experiment. A beam of light from a very bright source was projected into the eye of the reader from which it, in turn, was reflected into a camera and on to a sensitive plate of a moving film. Through this beam of light there was made to vibrate an electrically controlled tuning fork at a known rate, twenty-five vibrations per second, which produced the effect upon the sensitive plate of a series of dots instead of a continuous line. All that was needed to be done with the record was to count the number of dots when the direction of the dots was vertical and again when the direction of the dots was horizontal (when the eye was fixated the direction of the dots was vertical, when it moved the direction was horizontal), and thus both the number and duration of the fixation pauses could be accurately determined. The subject, too, wore the rims of glasses on which a bright bead was fastened. This was photographed in parallel with the record of dots just now mentioned. It was thus possible to distinguish between the movements of the head and those of the eyes. With the conditions under control and the movements of the eyes of the subjects the variable, it was possible to get an accurate record of the movements of the eyes when the subject was engaged in reading an easy selection. By selecting from each grade the records of average readers, a curve of improvement in reading from grade to grade based on objective records could be drawn. Improvement here was measured by the decreasing number of fixation points in the line, by a decreasing length of these pauses, and by a decrease in periods of confusion in which the eye would move back and forth. It is thus seen that this experiment fulfills very well the conditions of an experiment, in that it controls the conditions (except the inner conditions of the subject, such as attention and desire to cooperate), varies the causes, records the results, and makes careful provision for repetition. To make such an experiment the experimenter must of necessity have had training in the handling of the apparatus, in the stimulating of pupils to do their best for him, and in the careful interpretation of results.

III. The Experimental Method, B—Method of Parallel Groups. Unfortunately it is impossible to subject all of the factors which we wish to study to a rigidly scientific method of procedure such as we have just described. Frequently we desire to know how psychological principles work in the schoolroom itself, where the strictly experimental conditions are manifestly impossible to secure. The method commonly used to test out methods of procedure within the schoolroom is known as the Method of Parallel Groups. For example, in studying two different ways of improving skill in addition in arithmetic a standardized test would be given the total group. The pupils would then be ranked according to their scores on the addition tests, placing the first and fourth in one group and the second and third, in the other. The same process would be repeated with the next four individuals and with the next four until all the pupils would be divided into two groups equal in ability. Group I would receive instruction according to method A, and Group II according to method B. One teacher would teach both classes, emphasizing the two methods equally, and in every way bringing out the good points of each method. After a stated period another test similar to the one used at the beginning is given. (In addition in arithmetic the same test could be used.) Now the difference between the first and the last scores would be the gain for Group I and a similar difference would be the gain for Group II. By subtracting the gain in Group I from that in Group II we obtain the difference between the results of the two methods. We then treat the data statistically to determine whether or not the difference between the two gains is reliable, and if it is we say that method A is superior to method B in improving speed in addition. Pupils who are continually absent are not considered and record is kept to see whether or not one group is getting more help from home than the other. In a large group this factor of home study would most probably balance up between the two groups. It is not necessary that only two groups be compared either, for, within the same investigation the comparison may be made between two or three practiced groups and one control group.

IV. The Method of Tests and Statistics. While the method of statistics applies to all the methods previously mentioned, it plays such a great part in the treatment of test results that I have combined these two procedures into one, and have named it the Method of Tests and Statistics. During the last fifteen or twenty years there has grown up a carefully worked out method of testing individuals in an objective way in order to discover quantitatively the amounts of some mental traits possessed by them. Let us take arithmetic for example. Courtis has prepared for purposes of addition a set of examples consisting of nine three-place numbers, each example of which is equally easy to work. Now any normal fifth grade child could do all of them (24) if he had time enough, but the time is only eight minutes, and the number of examples done correctly in the time allowed is the score. Once we have scores, there is an immediate need of statistics, for the scores of a class come in quite disarranged. The statistical procedure would be in this instance, to find the highest score, then the lowest, and arrange in a vertical column a series of scores differing by steps of one. Let us suppose that the scores were: 9, 10, 7, 8, 7, 7, 6, 8, 9, 12, 13, 10, 11, 9. The highest is 13; the lowest, 6. We arrange the series as follows:

Scores	*Individuals*
13	1
12	1
11	1
10	2
9	3
8	2
7	3
6	1

This means that one person made a score of 13, one a score of 12, one a score of 11, two a score of 10, etc.

We can now study the scores by getting their average, their mid-point, their middle 50 per cent, and thus learning more and more about the scores and of the ability of the class in addition in arithmetic.

In the treatment of scores there frequently occur cases in which each pupil has two scores, such as a score in arithmetic and a score in reading. The question now arises as to how these two scores are related, as to the existing relation between reading and arithmetic as measured by these two tests. To discover this relationship we use the statistical term widely used in this field, the coefficient of correlation. By means of this device, called *r*, we obtain a measure of relationship between two traits in the same group of individuals. If the two traits resemble each other perfectly so that the same individual who ranks highest in one trait also ranks highest in the other, and the same individual should rank second in both traits, and so on until the lowest individual in one trait should be the lowest in the other, then the relation would be perfect, and the coefficient of correlation would be 1.00. This we call perfect resemblance. This would mean here that the boy who is best in reading is also best in arithmetic, the boy who is second in reading is second in arithmetic, etc., until the lowest boy in reading would also be the lowest in arithmetic. If no closer relation appears than chance the coefficient is 0.00. If, on the other hand, the individuals who ranked high in one trait should rank low in the other and vice versa, then negative correlation would appear, and the coefficient might even be -1.00. Rarely ever do we find perfect, either positive or negative resemblance. The application of this device to the problem at hand gave a correlation of .45 between reading and arithmetic in the same grade. A few illustrations will help clear up the meaning of this term, but only long study and much use will give an understanding of it. Correlations between brothers in the case of spelling range around .50, between twins around .80, between individuals taken from the general population, around 0.00. The coefficient of correlation between marks in algebra and those in English range around .55. Among other statistical measures the median and the mean, the semi-inter-quartile range and the standard deviation are most frequently used. These will be illustrated and discussed on a later page.

These two methods, the experimental and parallel group method, and the test and statistical, are the ones to employ when accurate scientific results are desired. It is important for the student, who wishes to master the material of this text in such a way that it will function in his daily life, to know the means by which the material, on which generalizations are based, is collected.

Borrowings from Other Fields of Psychology

From the various fields of psychology, educational psychology borrows whenever a usable fact about mental life has been discovered. Among these fields we shall discuss general psychology, genetic, abnormal, animal, social, and individual.

General psychology furnishes us with the fundamental principles of mental life, with some knowledge of inherited nature, with discussions of memory, of emotions, reasoning, and such like. In general, we have here descriptions and explanations of the normal human being experiencing and reacting to the ordinary situations of the day. While these principles of psychology are essential, they sometimes fail to answer specifically the question we want answered. For example, general psychology treats of perception. It describes the process of attaching meaning to objects, the manner of perceiving, and the errors of perception. But the student of education wants to know how the process of perception is developed in the field of reading, a specialized problem. General psychology treats of the process of learning in general; educational psychology treats of this general process also, but as preparation for an understanding of the learning of school subjects. General psychology treats of the reasoning process; educational psychology, of the process of reasoning as applied, for example, to the solutions of originals in geometry. General psychology is thus an essential preparation for educational psychology. It gives the background and fundamental principles of all mental life which educational psychology applies to the specific problems of the school.

Genetic psychology deals essentially with growth. It traces the mental trait to its origin. Where did it begin? How did it grow? When does an infant first yawn? What are his first reactions to light? What fear reactions appear without learning? These are samples of questions asked in this division of the subject. In brief, the origin and growth of mental traits claim attention. One investigator (Baldwin) has had the same children measured over a series of years (seven in 1925) with the Stanford-Binet tests of intelligence. Curves plotted with these data have shown that average children stay average from year to year, and that superior children at one age remain superior throughout the period of measurement. Monthly measures have been made on pre-school children in learning to sort cards, tests of motor control, tracing stars and diamonds, etc. The very shape of learning curves of little children appears to be somewhat different from those obtained with more mature subjects. Many learning curves have been plotted from data collected from more mature individuals, but it has been impossible to know just what the beginnings of the learning curves were like because some knowledge of the function was always present. In the present instance the children were so young at the beginning of the experiment that they could not even sort the cards into their appropriate piles. It was thus possible to study critically the very beginning of the curve in card sorting. Another investigator (Watson) has made careful observations and experiments on many infants from the time of their birth up to 200 days. He watched carefully for the appearance of reflexes and instincts, and has discovered three emotional reaction patterns—love, rage, fear—which seem to be inherited. Yet another investigator (Gesell) has photographed the typical reactions of infants at one month, four months, nine months, twelve months, eighteen months, etc., up to five or six years. Comparisons of these typical reactions were made with those of both backward and advanced children. By means of such careful investigations, there is being built up a body of accurate and trustworthy knowledge of the child's mental growth. This knowledge of mental development aids the teacher in understanding the nature of the child with whom she has to deal.

Recently there has been among educators much interest in *abnormal psychology* because it offers a means of explaining obscure causes for action in certain disciplinary cases which otherwise are inexplicable. This field of psychology is interested in abnormal manifestations of mental life wherever found. Hallucinations, dreams, feelings of unreality, various types of fears, melancholia, feelings of inferiority, of persecution, daydreams, negativism, somnambulisms and many other unusual mental activities are the material with which it works. Among children there sometimes occur feelings of inferiority which if allowed to go on unhindered may develop into very serious consequences, possibly into insanity. The student of abnormal psychology has made careful study of just such cases, and can give us many serviceable suggestions as to how the subject should be treated. Sometimes at the period of adolescence boys and girls may for a time lose all interest in their work, may become negative in their attitudes, and may live almost entirely in a world of their own imaginings. The treatment of Mildred in the following illustration is an example of how one investigator attempted to meet such a condition.

Mildred is one of the three cases analyzed and discussed in a recent book, *Three Problem Children.* This girl showed unusual sensitiveness on certain subjects, a "lack of interest, emotional dullness, and in general, a withdrawn, subjective attitude," a condition strongly suggesting insanity. Under the direction of students of insanity a thoroughgoing study was made of her entire personality. This included a survey of her physical development and general health; of her environment, which included home, school, and neighborhood conditions; and of her intellectual and emotional life. With this knowledge in hand, account is given of the treatment. This consisted of encouraging independence, changing the conditions in her home, getting her to join a Girls' Scout organization, encouraging her to visit the Natural History Museum, and in general to get a new perspective on life. From such material as this the educational psychologist has much light thrown upon the personality of unusual cases in the ordinary school environment. Thoroughgoing studies of the entire personality are unusually helpful to those who have to deal with personalities day after day, i. e., to the teachers. Abnormal psychology also treats of the feeble-minded and the backward. It has shown that these individuals can be educated to a certain extent, provided suitable material is presented and simplified so that a simple mind can comprehend it.

Experiments with the *behavior of animals* is not only a fascinating business on its own account, but has helped the student of mental life to formulate general laws of learning which are applicable to all animals. Human beings in general live under such a complex environment that it is frequently impossible to separate the devious pathways of development which the individual has traversed in reaching his present condition. With animals, on the contrary, their environment is frequently quite simple, and it is possible to control the conditions more rigidly from the very beginning of life. Professor Thorndike was one of the first to see the possibilities in experimenting upon animals. He confined some young cats in a small box containing a latch which opened a small door. On the outside of the box some food was placed in plain view of the cat. Thus it was possible to observe the cat from the very beginning of his learning until he could solve the problem in a few seconds. From many such experiments the laws of learning were deduced which seem to hold in all learning, human or animal. Some recent experiments by Wolfgang Köhler with chimpanzees, as subjects, seem to show that these animals react considerably more like man than cats do. I shall quote one from these most interesting experiments. "For over an hour Sultan (one of the chimpanzees) had balanced in vain, trying among other things the following procedure: one stick was stretched as far as possible in the direction of the fruit, and then carefully pushed still farther by the second stick until the goal was actually touched. Thus, a contact was made with the goal, but not one which could be used. The vain attempt at a solution was nevertheless fully carried out, so as to constitute a uniform configuration connecting the animal with the fruit. The experiment was then given up, and Köhler departed. Sultan, however, retained the two bamboo sticks, and the keeper remained at his post. It was the keeper who observed the animal, first sitting upon a box which stood near the bars, then rising, picking up the sticks, and after reseating himself upon the box, beginning to play with them aimlessly. In the course of the procedure it happened by chance that Sultan held one stick in each hand in such a way that they came in line with one another. He then placed the smaller one in the opening of the larger, sprang at once to the bars, towards which his back had previously been turned, and began to draw in one of the bananas with the double stick. 'I called to the director, though in the meantime the sticks had fallen apart, because they had not been well fitted together; but the animal immediately replaced them.' So runs the report of the keeper, and Köhler himself arrived in time to see the rest of the animal's performance of refitting the sticks together and securing the fruit. After his first success Sultan repeated the acts a number of times, without stopping to eat until he had fetched into his cage not only all the fruit, but also a number of other things. He appeared to enjoy the act, and he retained the method of solution so well that on the following day he was able to construct a still longer stick from three bamboo stalks." [1]

Sometimes the stimulus to any individual's activity is the action of another individual; this is a phase of *social psychology*. Two people are both deeply interested in a sunset of rare beauty and totally unaware of the other's actions, when, by some movement of one or the other, each is made aware of the other's presence and of the object of his thought. The actions and the thoughts of each are now different, for each one has the added knowledge of another individual's sharing his thoughts, and each will probably respond a little differently than before. Of course, the interaction may be more direct than this in that A may stimulate B who in turn stimulates A. The teacher having under his guidance thirty or forty pupils, each being stimulated daily by the teacher, who is in turn stimulated by them, needs to know a good deal about social interaction. In the discussion of the growth of that "we-feeling," that feeling of social consciousness which we see exemplified in the school spirit, the gang, the community spirit, etc., we find an important principle helpful in directing the social education of the individual child.

Individual psychology is concerned largely with the differences in mental and physical traits which exist among individuals frequently in the same grade or of the same age, and with the causes of these differences. It attempts to answer the questions relating to individual differences raised on page 5, or it would be truer to say that teachers have become sensitive to such problems as were raised there because of the modern developments in individual psychology. Its chief concern, then, has always been to perfect instruments of precision to measure the amount of differences between individuals. They have done this in two major fields: (1) by the development of intelligence tests, and (2) by the construction of tests of classroom products.

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[1] Koffka, Kurt. *The Growth of the Mind*, pp. 198–199, 1924. Harcourt Brace and Company, New York.

The use of intelligence tests, beginning with the publication of Binet's scale in 1905, has been very widespread. They attempt to get at native capacities by using tests and questions which all have had an opportunity to learn, calculating that the differences in amount learned will be due to native endowment. The Stanford Revision of the Binet-Simon tests is generally regarded as the best of these tests for American children. It consists of a series of problems arranged for each age. The problems are so selected that practically all children under ordinary circumstances will have had an opportunity to learn them. The tests are placed at a certain age because from 60 to 75 per cent of normal children perform them at that age. Thus, age standards are used. This makes possible the comparison of children of different chronological ages. For example, a child of ten years and a child of twelve years may have the really same mental age, that is, they may make the same scores on this test standardized for age. By a mental age of ten we mean that this child can perform the same tasks which the average child can perform at that age. We find wide differences in mental age in children of the same chronological age and wide differences in mental age among children of the same grade. The test just discussed is an individual test, that is, only one child can be tested at one time. In recent years there have developed group tests of intelligence which will test from thirty to forty children at one time. These are very economical in the matter of the amount of time required to give and score them, and when carefully administered will give reliable results. The problems are so arranged that much thinking and little writing is required of the subjects being tested.

At the same time with the development of these mental alertness or intelligence tests, there have been developed tests of educational products. These tests, although somewhat similar to the ordinary examination, are composed of material much more carefully selected, are more objective in scoring, have more carefully worked out directions for giving and scoring, and in general are far more precise instruments of measurement than the ordinary examination. Moreover, by giving the same tests to a large number of children, it has been possible to establish certain median or average scores for each grade or age, so that comparisons may be made between the standards thus established and the attainment of any grade in any community. It is thus possible to tell whether this fifth grade is as good in reading as the average of the country at large, or whether it is as good as the same grade last year. These tests are now very largely used in the promotion and classification of children, and for purposes of diagnosing the particular difficulties which arise from time to time in the knowledge of the individual child.

SUMMARY

Educational psychology deals with those phases of psychology which apply to the growing boys and girls, particularly when they are in the school environment. It includes the study of the inheritance of traits, their modification in their interaction with environment, and the study of the individual differences resulting from this interaction. Economy in learning, the ordering of material, the distribution of reviews, interest, transfer of training, and school discipline are samples of topics considered. Experiments of the ordinary laboratory type, parallel groups, tests and statistics, and the questionnaire are the four leading methods used in gathering data. Indeed the statistical method more often than not appears in all the other methods. In determining the reliability of results, the gain of the practiced group over the control group, the relationships between traits, and in various other ways the knowledge of statistics is extremely important.

Happily human nature is one and knowledge gained in one field may be used in another field of investigation, and so the educational psychologist may borrow from other fields of psychology. From general psychology, he borrows his general principles, his methods of attack, his theoretical discussions; from social psychology, he learns of the growth of social consciousness, of the interaction of individuals in their daily intercourse; from animal psychology, he sees learning in a simplified form where the conditions may be more perfectly controlled; from abnormal psychology, he learns of drives, of complexes, and of feeble-mindedness, which facts help him to see the need of early treatment of children so afflicted; from genetic psychology, he learns of early learning curves and systematic observations on the lives of children; and, finally, from individual psychology, he learns of measurements and tests by means of which individual differences are measured. Of these, individual and genetic may be thought of as distinctly educational psychology.

QUESTIONS AND EXERCISES

1. How does educational psychology differ from other fields of psychology?
2. What are some of its problems?
3. How do these problems differ from those in general psychology? How do they resemble them?
4. What is meant by the experimental method? Compare with the method of parallel groups. Which is more scientific? Why?
5. Point out some of the difficulties of the questionnaire method.
6. If replies were received from 65 per cent questioned, could valid conclusions about the whole group be drawn? Why?
7. State which method you would use in investigating the following problems:—
    a. Deciding which is the best way to introduce the study of fractions.
    b. The way the eye moves in reading.
    c. The effect of praise, disapproval, and neglect on learning.
    d. The most interesting school subject in high school.
    e. The most economical methods in memorizing.
    f. The attainment of a class in reading.
8. Why does educational psychology borrow from other fields of psychology?
9. Name five fields of psychology and two items borrowed from each field.
10. Fill in the proper words in the following sentences:—
    a. Educational psychology differs from general psychology in having a more———field of———and in dealing more largely with the mental traits of ———rather than with mature individuals.
    b. In the method of parallel groups there are at least ———groups: the———group and the——— group.
    c. In the experimental method effort is made to———

the conditions,———the causes, and———the results. Provision is always made for———the experiment, and accurate results are more certain when the experimenter is———.

d. No conclusions can be drawn from the results of a questionnaire unless———per cent of the questions are answered.

e. One can hardly get very far in studying educational psychology without some knowledge of———, for nearly all results must be tested for their———.

f. ———psychology is most closely related to educational psychology.

g. One would acquire some knowledge of the interaction of individuals in———psychology.

REFERENCES

A list of books bearing on the fields of psychology

General Psychology

Woodworth, R. S. *Psychology*, 1921.
Watson, J. B. *Psychology from the Standpoint of a Behaviorist*, 1924.
Hunter, W. S. *General Psychology*, 1919.
Gates, A. I. *Psychology for Students of Education*, 1923.
Gates, A. I. *Elementary Psychology*, 1925.
Perrin, F. A. C., and Klein, D. B. *Psychology*, 1926.
Dashiell. *Fundamentals of Objective Psychology*, 1928.

Genetic Psychology

Gesell, Arnold. *Mental Growth of the Pre-School Child*, 1925.
Baldwin, Bird T., and Stecher, Lorle I. *Psychology of the Pre-School Child*, 1925.
Johnson, Buford J. *Mental Growth of Children*, 1925.
Koffka, Kurt. *Growth of the Mind*, 1925.

Abnormal Psychology

Morgan, John J. B. *The Psychology of the Unadjusted Child*, 1924.
Three Problem Children. By the Joint Committee on Methods of Preventing Delinquency, 1925.
Mateer, Florence. *The Unstable Child*, 1924.
Hollingworth, Leta S. *The Psychology of the Subnormal Child*, 1923.

Social Psychology

Allport, F. H. *Social Psychology*, 1924.
McDougall, William. *An Introduction to Social Psychology*, 1908.
Gault, R. H. *Social Psychology: The Basis of Behavior Called Social*, 1923.
Woodworth, R. S. *Dynamic Psychology*, 1918.
Ellwood, C. A. *An Introduction to Social Psychology*, 1917.
Bernard, L. L. *An Introduction to Social Psychology*, 1927.

Animal Psychology

Watson, J. B. *Behavior: An Introduction to Comparative Psychology*, 1914.
Smith, E. M. *Mind in Animals*, 1915.
Holmes, S. J. *Evolution of Animal Intelligence*, 1911.
Holmes, S. J. *Studies in Animal Behavior*, 1916.
Washburn, M. F. *Animal Mind*, 1908.
Köhler, W. *The Mentality of Apes*, 1925.
Thorndike, E. L. *Animal Intelligence, Experimental Studies*. Revised edition, 1911.

Individual Psychology

Thorndike, E. L. *Educational Psychology*, Vol. III, 1914.
Pintner, Rudolph. *Intelligence Testing*, 1923.
Trabue, M. R. *Measuring Results in Education*, 1924.
Terman, L. M. *The Measurement of Intelligence*, 1916.
Monroe, W. S., DeVoss, J. C., and Kelly, F. G. *Educational Tests and Measurements*, 1924.
McCall, W. A. *How to Measure in Education*, 1922.
Freeman, F. N. *Mental Tests*, 1926.

CHAPTER II

INHERITED NATURE

Education seeks to prepare individuals to take their places in a complicated society. To accomplish this successfully inherited nature must be guided and directed into attitudes, habits, and feelings which are socially desirable. These could be more easily attained if we could know accurately the inherited nature with which we must deal. We should like to know what traits can be depended upon to appear without much aid from the environment, and at what period of life they normally appear. For example, the impulse of rivalry is so strong in a certain youth that he will go to any length in order to win. He plans out his campaigns with meticulous care and if he loses broods over his defeat. His urge to win is so strong that he loses friends and, in general, makes himself disagreeable. Now just how much of his condition is inherited? Are these simply habits which urge him on so strongly? Or again, at the age of ten John Williams begins to collect tobacco tags and pictures of famous baseball players; a little earlier he may have brought together marbles in large quantities or birds' eggs. Is there an innate urge to collect, or is this a habit learned much as other habits are? In brief, we want to discover, if possible, those original traits which underlie many of the activities of life, and seek to direct them into worth-while habits.

THE MANNER OF INHERITANCE

Whatever is transmitted from one generation to the next must go through the germ cells. These lead an existence independent of the body cells, and contain within themselves possibilities of development. Under normal conditions of nutrition these cells develop into the embryo, and this in turn into the infant. From the very moment of the union of the spermatozoön of the male with the ovum of the female, there are determined certain lines of development. For example, whether the person developing therefrom is tall or short, has red hair or brown hair, blue eyes or brown eyes, Roman nose or pug nose, whether he shall be bright or stupid —is already determined, if normal environment is provided. Nothing that his parents have acquired during their lifetimes is transmitted, but only possibilities of development similar to what the parents started with. As far as is certainly known, there is no way by which the somatic or body cells can affect the germ cells. This means then that if a mother practiced on the piano for eight hours a day for years until she was a skilled pianist, her daughter would be no whit better off so far as music goes than if she had not practiced one hour. Only the capacity for development which the mother and father enjoyed is inherited. Even this capacity would not develop were there not a favorable musical environment. The nature of inheritance is admirably set forth in the following quotation: "As to the dependence on the stuff that they are made of, research has shown that the substances passed from parent to offspring giving rise to the phenomenon of inheritance are a great number of discrete packets of diverse chemicals, imbedded in a less developed mass of material. The masses formed by the grouping of these packets are visible under the microscope as chromosomes. The number of different kinds of packets that go into the beginning of any individual is very great, running into the hundreds of thousands. They are not massed in a haphazard way, but are arranged in a definite manner; so that the young organism is like a well-organized chemical laboratory with many reagents so arranged in containers as to react with each other in an orderly way, producing a definite and harmonious result." [1] Many of these packets by the time of birth have developed into definite patterns within nerves and muscles, so that if the proper stimulus is provided the responses may follow very quickly and accurately.

Some Traits Appearing at Birth

Traits appearing at birth are certainly inherited. All that seems necessary for their activity is a stimulus of some kind. The neural pathways are already coördinated and ready for action. Some of these reactions which appear within the first ten or fifteen days after birth are given below. Many of them have been observed to take place in normal children within the first six hours after birth, while all of them appear within the first few days.

A few of these such as sneezing, yawning, jumping at loud sounds, grasping, curling the toes when brought near the fire, raising and holding up the head, turning the head in such a way as to get air when placed upon the face, are over with quickly (reflex); while certain others such as putting thumb in mouth, sucking, fixating a bright light, crying, following a moving object with the eyes, seem to persist somewhat (instinct). Suckling does behave remarkably like an instinct. It appears at birth. One investigator (Blanton) reports that rubber nipples were sucked immediately after birth, and when these for some reason or other ran short, the cleansed finger of the physician's rubber glove was sufficient to provoke the sucking responses. Moreover, touching a waking infant lightly on one cheek when the infant is hungry elicits a turning of the mouth in that direction, but when he is not, the response does not always follow. Even in sleep when there is slight pressure on the lips they purse up and on some occasions actual sucking movements are observed. Another investigator (Shinn) reports sucking of the cheek, if hungry, whenever the lips came in contact with such an object, and of licking the cheek when not hungry. (This occurred at the age of two months.) After some months the act of sucking becomes entirely voluntary.

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[1] Jennings, H. S. "Heredity and Environment," *Scientific Monthly*, 1924, Vol. XIX, p. 226.

Certain emotional responses also appear at birth. Watson, after a thoroughgoing investigation of many infants, reports three emotions appearing at birth—*fear*, *rage*, and *love*. Fear occurs at the withdrawal of support and at the stimulation of a loud sound. The responses are the ordinary fear responses, such as the checking of the breath, jumping, by which is meant a sudden complicated movement of the whole body, crying, and other responses which have not been definitely worked out. The stimulus for rage consists of restraint of bodily movement. At this stimulation the whole body stiffens, the breathing stops temporarily, the face becomes red, which may gradually change to blue. The stimulus to love is a stroking of the skin or sex organs, or of some other "erogenous zone," rocking, riding on the foot, etc. Response consists of the cessation of crying and the substitution of gurgling and cooing. There are also certain changes in respiration and circulation. These connections between stimulation and response seem to be well agreed upon.

In addition to these reflexes, instincts, and emotions which appear at birth or soon thereafter, there is inherited also what is known as a general capacity for learning. Much of this quality results in an individual who learns quickly, who even as a child learns more rapidly than the average, and who as an adult is able to reason better and to think more accurately about more general and more abstract conditions than those with less of this trait. The evidence for the inheritance of this trait is rather convincing.

EVIDENCE THAT GENERAL MENTAL CAPACITY IS INHERITED

Feeble-mindedness runs in families. Competent authorities agree that about 65 per cent of feeble-mindedness is directly traceable to tainted inheritance. These children show their physical and mental weaknesses soon after birth. They walk later, talk later, and, in general, develop more slowly both mentally and physically than normal children. Moreover, their mental development is apt to stop permanently somewhere between the second and ninth year of the normal child's development. They, even at maturity, are unable to take and maintain a definite direction in their thinking, are unable to criticize adequately their acts or thoughts, and to modify their acts in order to reach a definite goal (Binet). It seems in this case that the quality of the total human organism is inferior to the average. These individuals may be trained to form habits, the complexity of which depends on the degree of subnormality, but their feeble minds can never attain normality, whatever the amount of their training. Sometimes these individuals do not develop a cortex. In such cases they seem to be totally unable to learn. One infant is reported who, at the end of the tenth week, had to be fed with a spoon, i. e., even the mechanism so deeply embedded as suckling presently ceases to function. Moreover, no expression at all ever seems to have swept over the face of the child (Edinger and Fisher).

The approximate constancy of the intelligence quotient (I.Q.) also argues for the inheritance of general mental capacity. The intelligence quotient is arrived at by giving one of the standard intelligence tests, and then by calculating the number of points or mental months made by the subject. The problems have been standardized at each age by giving them to large numbers of children at the different ages. With the number of problems passed by each child before us, it is possible to refer each child's score to the norm secured by calculating the median performance at each age. These points transmuted into terms of these median scores give us mental age. The ratio between this mental age and the chronological age gives us the I.Q., or intelligence quotient. Children have been given intelligence tests—Stanford Revision—on successive occasions (Baldwin), and there has been found a fairly constant ratio between mental and chronological age for successive years. For example, a child whose intelligence quotient is normal (I.Q. equals 100) at three years will most probably be normal at six years, at ten years, and at fourteen years, etc., i. e., his I.Q. of 100 may be 96, 105, 94, 98, and 104 on successive measurements. One actual case (Baldwin and Stecher) had I.Q.'s of 88, 92, 96, 94, 96 on successive yearly measurements, while another ran like this: 100, 104, 101, 101, 105. Again, low intelligence quotients (stupid children, as we say) remain low with a tendency to become lower as the age increases, and on the other hand, superior children remain superior. One child scored the following I.Q.'s on successive yearly measurements: 122, 125, 119, 121, and 128. There are a few cases (Terman) where children have experienced radically different environment, and yet their rate of growth has not appreciably changed. In some cases much improved environment has tended to increase the I.Q. for a time, but subsequently it seems to have dropped back to its original position. Contrariwise, it has been reported (Woolley) that pre-school training does tend to increase the rate of growth to an appreciable extent. Numerous investigators have shown that, on the average, the measure of brightness remains fairly constant (for the statistically minded, it is a probable error of 4. 5 points in the case of the Stanford Revision, when successive measures are taken), and that the child who is bright at four is the same at seven and about the same at twelve years, and vice versa in the case of the dull child.

Studies of correlations of twins and of brothers and sisters (sibs) indicate that capacity is largely determined by heredity. It has been shown (Thorndike) that in six traits the average correlation in the case of twins was .78, while brothers and sisters (sibs) averaged about .40. The similarity of environment in the case of a pair of twins is not much more close than in the case of a pair of sibs. It seems reasonable, therefore, to interpret the major part of the difference between .40 and .78 as being due to heredity since the environments are so similar. If the difference between a correlation of .40 and one of .78 is due to heredity, which it seems to be, this is clear evidence of the inheritance of mental capacity. And since Thorndike used six varieties of tests including those of such general nature as opposites and misspelled word tests, it may be concluded that the mental capacities tested are general in nature. The coefficient of correlation is a statistical device by which relations between sets of data may be expressed mathematically and in one figure or set of figures (see pages 268, 269). The closest possible relationship would be 1.00, in which there would be a perfect correspondence. For example, let us suppose that ten pairs of twins are tested in their capacity to multiply three-place numbers by two-place numbers. For perfect resemblance each member of the twin pair would have exactly the same corresponding rank in the group, i. e., if you knew that Twin A was the best in multiplication you would know immediately that his twin brother would be alike in this trait. Now these conditions are about as nearly met in the case of twins as in any other measure of relationship. The resemblance is strikingly high, and the difference between the average correlation of twins and sibs might be taken as due to heredity. Identical twins (that is, those developed from the same fertilized ovum) have been shown (Gesell) to resemble each other in a large number of details. At age eight years the principal resemblances were indeed remarkable. The upper incisors were at about the same stage in their eruption, the children weighed within a pound of each other, the length of head and girth of head differed only in tenths of millimeters, and even a slightly pigmented mole appeared at approximately the same portion of the face. The palm prints and the bone development as studied with the X-ray were so nearly alike that only a careful study of minute details could discover any differences. Again, their mental development went along in parallel with their physical development. Their I.Q.'s were quite similar, and even in the details of single tests the likeness was most remarkable. In the vocabulary test, for instance, at the age of nine years A knew 67 words and B sixty-five out of Terman's one hundred words. This closeness of resemblance in the case of the I.Q. is further evidence for the inheritance of general mental capacity.

Thus the evidence from the inheritance of feeble-mindedness, from the constancy of the intelligence quotient, and from the correlation of twins and sibs, points to the inheritance of such physiological mechanisms which respond quite differently to environment. So great may the resulting differences be that, while one individual conquers his environment or even rises to great heights in changing it, another seems totally confused in attempting to respond normally to it, and still another makes no attempt whatever to meet the ordinary situations confronting him.

Heredity, it is generally agreed, furnishes us with a large number of simple responses to definite stimuli, with a few more complicated pattern reactions which seem to have at times considerable visceral accompaniment, and with the general quality of the developing organism. These traits either appear at birth or so early in life that they probably could not have been learned, although even here we must not be too sure, as conditioning or simple learning appears very early in the most unexpected fashion. From these data, generally agreed upon, we pass to the consideration of matters highly controversial.

Traits more complicated than those just described sometimes appear later in life, with very little learning necessary for their appearance. A young lad thirteen or fourteen years of age, previously careless about his dress, rather suddenly becomes much concerned about it. His hair is combed constantly, his shoes are shined, he importunes his parents to purchase him new clothes. He has queer urges and strivings which he does not understand, and may become terribly infatuated either with a girl of his own age or with some older woman. In brief, he has certain love attitudes which parallel the maturing of the organs of sex. These late appearing phenomena offer considerable difficulty to those who would define original nature as that which appears at birth. It is, of course, possible that those structures which underlie the feelings of pleasantness at the stroking of the "erogenous" zones in early infancy may have been slowly growing until they have arrived rather suddenly, to be sure, at maturity. The explanation of the appearance of inherited nature after birth has been attributed to the coming to maturity of certain specific neural patterns with their correlated action patterns.

The Maturation of Instincts

There is a respectable amount of evidence which points to the maturation of structure, accompanied by the appearance of certain traits which before did not appear.

The evidence from myelinization is accumulative. Pathways from one part of the brain to another become covered with myelin (or medullary) sheaths at different times, and this is probably, though not certainly, correlated with the accompanying development of function (Ladd and Woodworth). "The inward-growing or sensory axones of the cerebrum develop before the outward-going or motor; and these in turn before the numerous 'association' axones which extend from one part of the cortex to another" (Physiological Psychology, page 58, 1915). It seems neurologically possible, then, for the action of certain nerve fibers to be so changed that new behavior patterns may appear with but little coöperation of the environment. Moreover, it is also probable that resistance at the synapses may be due either to lack of contact between contiguous neurones, or else to a membrane of separation which mere maturity may change.

Certain observed behavior of infants seems to point to a progressively deferred appearance of specific traits, e. g., blinking is not present at birth; at fifty-five days it is absent; at seventy-five days it is slightly present; at eighty-three days present in one-half the tests, and at 124 days present in all the tests (Watson). Thrusting down of the legs before walking is developing at about seven or eight months, and seems somewhat comparable to the "extensor thrust" of the animals. The discrimination of color, too, certainly seems to depend on a certain kind of maturing, for it rarely ever appears until well on into the second year, and usually it is five years after birth before normal children can name the four primary colors without an error.

The evidence from experiments with lower animals is always by analogy and here is not unambiguous. Some swallows were confined in a wire box not much larger than the nest in which they were hatched. They were kept there until fully fledged. When they were released, two flew, but with some difficulty, but the other two flew almost as well as the mature birds (Spalding). This is one of the clearest cases of maturation on record. No other cause could have possibly operated in this connection, for even when the experiment was repeated similar results were obtained. Some other experimenters (Breed and Shepard) prevented chicks from pecking grain during periods ranging from three to five days immediately following the time of hatching. These force-fed chicks were then permitted to peck in the normal way, and a careful record of the result was kept. In general, the force-fed chicks in two days caught up with the control group. The authors interpret these rather surprising results as evidence of maturation. The findings of this investigation have been carefully checked (Bird) and found to be substantially correct. The results are the same, but the interpretation is different, for the latter investigator, together with some other psychologists (Hunter, Watson, Allport), thinks that this more rapid learning during the first two days of the force-fed group is due to the general maturation of the nerve cells and growth of the muscles which coöperate in the act of pecking, and not to the maturation of those cells concerned with the specific instinct of pecking. Other psychologists call attention to the similarity of their learning curves to those of the ordinary type. Furthermore, certain synaptic connections do seem to mature in cats to such an extent that they kill mice without social example of any kind (Bloomfield). A good illustration of this instinct follows. Recently a young cat about four months old was placed in the same large tin can with a small mouse. At first the cat showed extreme fear, attempting to climb up the sides of the tall can. Then, suddenly, even while the eyes of the observer were upon him, his demeanor changed and he seized the mouse just behind the ears with a crushing grip. The mouse was killed instantly. When the observer caught the mouse by the tail and pulled at him, the cat held on the tighter and growled, and even struck at the hand with his paw. It seemed evident to the observer that the cat had never before killed a mouse.

The evidence from the differential myelinization of the nervous pathways, from the actual observations of infants, as well as from the observation of animals, argues for the probability of deferred instincts due to the maturation of gland, muscle, or nerve cells.

How, then, can we determine whether or not a trait, any trait, is inherited? What measurements can we make to aid us in this undertaking? There are a few principles which aid us in judging whether or not a trait is instinctive.

Criteria of Instinctiveness

1. If a trait appears at birth or even a few days later it is surely instinctive. There are now available a large number of observations upon infants immediately after birth, and these are at hand ready to be used.

2. If a trait appears after birth, but with no opportunity for learning, then it is instinctive. This sounds very plausible, but is not very useful. Few observations of children have been carefully enough made to be certain that the traits appearing after birth have not been learned. Certain fears, such as fear of the dark, have been shown to be learned, although on the face of it they seem to be instinctive.

3. Universality. If a trait appears universally in all people, then it is probably instinctive. This principle has been taken to task very sharply of late. Its opponents say that the environments of all people are quite similar, and hence call out a large number of similar habits. These, because of their universality, seem to be inherited. For example, all children are interested in moving from place to place, and hence in walking. The proponents of the use of universality as a criterion of instinctiveness find a certain type of responses, such as those appearing in hunger, fear, and anger, common to all races of individuals who live under widely varying environments. Is walking an instinct? Ac-

cording to the proponents of universality, it is, since it occurs in all normal individuals. According to the opponents it is not, but is learned much as other habits are learned. We shall try to apply these criteria to our list of instincts, and have listed below those traits which seem to depend mainly, though not wholly, on inherited nature.

Below is a list of traits (probably inherited) interesting to students of education. It is not a complete list.

The following classification is made according to the type of situation which arouses the response. The procedure is merely a matter of convenience, for some other classification would do quite as well.

I. Responses to Organic Stimuli:—
  Food-getting
  Sex.
II. Responses to Objects in the Environment:—
  Sensitivities
  Vocalization
  Manipulation
  Visual Exploration.
III. Responses to Others:—
  Mastery
  Rivalry
  Fighting.

I. Responses to Organic Urges

Food-getting. The instinctive bases of food-getting have been treated on page 28. These various simple reactions patterns early in life become conditioned in many sorts of ways, so that by the time the child has arrived at the school his habits of eating are pretty well fixed. He has formed strong preferences for foods of a certain kind, and his hours of eating have become habitual. Sometimes these preferences are for highly flavored foods which cause malnutrition, so that children grow up undernourished and more inefficient than need be.

The Sex Instinct. It is probable that from the very first days of life the beginnings of the sex impulse appear. If a healthy infant is placed upon one's knees and gently rocked or patted, smiling is apt to appear, or if crying has been going on, the crying ceases. Similar results occur whenever the bottom of the foot is gently stroked or the infant is swayed slowly backward and forward, or when the armpits or the lower ribs are stimulated. Moreover, the act of sucking seems to be pleasurable in itself. These pleasure resulting areas are called "erogenous" zones and include the sex organs proper. All of these pleasurable feelings are said to be connected indirectly with the sex impulse. Appearing as it does at birth, this most important impulse plays an integral part in the life of school children. On its physiological side, particularly during the adolescent years, the sex cells pour into the blood stream hormones which are directly concerned with the development of physical beauty; and on the mental side, the maturing of these cells makes the developing child susceptible to urges and drives the origin of which he may be quite ignorant.

During the period of adolescence there is an accelerating of the growth of almost all the organs of the body. The average age of girls for the beginning of this period is from twelve to thirteen years, and for boys fourteen. These, however, are merely average figures, for the usual variation with boys is from eleven or twelve to eighteen, with an average at about fourteen. In the case of girls, the range may be from ten to twenty-one, with much the largest numbers at fourteen and fifteen. Other phases of the physiological maturing are the accelerated growth in the height and weight, growth of the muscles, the lungs, heart, and arteries, and changes in the voice.

Calculations from a table of Boas give the following average differences in increments of growth from year to year. The quantities are expressed in centimeters.

TABLE I

Growth in Height from Year to Year (Boas)

Centimeters

Years	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
Boys		4.87	4.87	4.42	4.44	5.26	6.39	7.33	5.18	4.01	2.16
Girls		4.93	5.13	5.35	5.92	6.17	4.81	3.20	1.53	1.11	

The greatest difference between the averages of growth for any two years in boys occurs between 14.5 and 15.5 years, when the boys grow 7.33 centimeters; while the corresponding difference among the girls appears during years 12.5 to 13.5 when they grow 6.17 centimeters. Similar figures hold in the case of weight. Muscles grow at an astonishing rate, thus forming about 27 per cent of the total body weight at eight years, and 43 or 44 per cent at sixteen years. The heart also grows rapidly at this period, causing an increase in blood pressure and a slight rise in temperature. There is too a great increase in lung capacity. The changes of the voice are well known. In boys there is a drop of about an octave, and in girls a similar drop, but less marked, and there seems to be a change to a richer quality.

Along with this other physiological growth, the sex organs mature rapidly. The cells of Leidig, particularly, pour their hormones into the blood stream causing a general heightening of tonus in all these organs. These internal physiological changes produce in the adolescent new urges and drives. Boys and girls heretofore only casually interested in each other may strangely enough either form mutual aversions followed by a great interest, or the interest may begin at once. These are the days of puppy love so delightfully and truthfully described in Booth Tarkington's *Seventeen*. Moreover, these adolescents become greatly interested in their personal appearance. Recently I noticed a youth of about seventeen years dressed in knickers, with stockings and sweater matched. He was so immaculately clothed that my attention was drawn to him. It was not long before he drew forth a comb and began to comb his hair. This interest in his personal appearance is in strange contrast to that of the tousled-headed boy with stockings down and torn shirt playing football on the back lot. This period of adolescence with its great sex urge coloring all other activities has been aptly characterized as the period of storm and stress (Sturm und Drang).

Further manifestations of this vital urge are indicated by the percentages of boys and girls of high school age who say that they like adult fiction. Boys and girls in several American schools, from the sixth grade through high school, were asked to write down the names of five books that they liked best of all. These books were then classified and the percentage of them appearing at each age was computed. These percentages appear in Table II.

TABLE II

Percentage at Each Age Choosing Books of Adult Fiction

Age	*9–11*	*12–13*	*14–16*	*17–18*
Number Boys	59	253	846	283
Number Girls	87	336	1195	414
Adult Fiction				
Boys	4	6	18	30
Girls	15	33	45	58

It has just been shown that the appearance of adolescence is made with boys on an average at age fourteen, and with girls at age twelve or thirteen. This interest in novels dealing with love affairs goes somewhat parallel with this new urge, for at the years twelve to thirteen only 6 per cent of the books chosen by boys are classed as adult fiction, while at years fourteen to sixteen this percentage has increased to eighteen. This is the largest increase between any two age groups. On the other hand, girls have their greatest increase between the ages of eleven and twelve or thirteen. This increase of interest in romantic literature, then, is undoubtedly connected with the maturation of the sex instinct.

Thus this perfectly decent and all-important urge ramifies rather broadly in the life of adolescents. The darker side of the picture needs to be shown. On account of delayed marriage there has grown up around all sex matters insinuations of indecencies which are indirectly related to bad sex habits and improper mental adjustments in relation to sex matters. A more open and direct treatment of the whole business with full explanations of the biological functions, together with the development of a clean attitude towards sex, undoubtedly would aid in forming a more wholesome attitude toward, and outlook upon, these matters.

II. Responses to Objects in the Environment

Sensitivities. All of the sense organs when properly stimulated give forth characteristic responses. As has been shown in the case of vision, the eyes followed a moving light or any other object that attracts them by their movements. It is not known just when the discrimination of colors appears, but Terman in his Stanford Revision of the Binet tests has placed the naming without error of each of the four primary colors at five years. Perceiving light waves varying from 390 to 755 million million vibrations per second depends upon the inherited structure of the organism. Probably nothing that an individual could do would change these limits. One observer (Shinn) reports that a little girl began suddenly to name red at sixteen months old, and that a month later she began spontaneously to name yellow and blue. Light and dark were readily distinguished during the fourteenth month.

Infants at birth probably do not hear normally, since the tympanum is packed with areolar tissue (Champneys), and because nerve paths are functioning only as far as the lower cerebral centers (Flechsig). On the other hand, the infant during the first day or two reacts to sharp, sudden sounds by jumping and throwing up his hands. Again, there is distinct limitation to the number of vibrations to which the human ear is attuned, this number being between 16 and about 40,000 vibrations per second.

The sensitivity of the skin seems to be best developed about the face, and especially about the mouth and eyes. The palms of the hands and the soles of the feet seem also to be quite sensitive. Otherwise, sensitivity is more dull than in adults. Of twenty-one sleeping infants prickled lightly upon the wrist, thirteen responded with a movement of the hand and eight did not (Blanton). The same investigator reports the lustiest of cries by newborn infants when cleansed with oil. To warmth, the infant responds by curling his toes, and to cold by a certain trembling. Moreover, kicking was recorded when drops of alcohol were placed upon the lower abdomen. All told, in the majority of cases, the response to dermal stimulation seems quite certain.

Infants for weeks after birth swallow the strongest medicines with apparent indifference. But, even here, sugar and weak quinine solutions excite sucking. When strong quinine solutions are used, some sort of grimace appears; while very strong quinine solutions may produce protrusion of the tongue and even crying. On the other hand, certain infants have been known to refuse cow's milk until it was sweetened. Except for this last instance, the general inference would be that taste is very poorly developed. The elementary qualities, sour, salt, sweet, and bitter, are also determined by heredity.

There seems to be an absence of any spontaneous reaction to smell, but certain ones may be stimulated artificially. Response to petroleum or amber oil placed on the upper lip seems curiously like the reaction to taste, i. e., graduated responses due to the concentration of the liquid as follows: sucking movements, grimaces, and then choking (Shinn after Lenzmer).

Many infants give evidences of discomfort if they are held long in one position. Any change in position may at times produce quiet.

Thirst and hunger both produce crying, which may apparently be appeased by either water or food. Organic pain seems to be felt quite early as in colic. Stopping the nostrils produces crying in a few seconds.

In general the reactions resulting in sensitivities are most certainly instinctive. All or nearly all may be stimulated at birth, and some of them appear with but very little aid from the outside.

Vocalization. Within the first thirty days of life the ordinary child makes a large number of sounds. Crying, gurgling, and cooing appear almost at birth. Not even all children cry alike, some of them making sounds remarkably like "a" in "at," and others like "u" in "cut"; others still begin with "w" and end in "a." Some other infants have cries differing from these. The cry from organic pain as in colic is apt to start very high, and may slide down gradually to the middle of the scale. During the first thirty days the following sounds have been recorded (Blanton):—

Consonants.

m with *a* as ma (at)
n in *nga* (nat)
g as in *gah*
h as in *ha* (at)
w as in *wah* (at)
r as in *rah* (at)
r as in *burr*
y as in *yah*

Vowels.
o as in *owl*
e as in *feel*
oo as in *pool*
a as in *and*
a as in *father* (relatively rare).

Moreover, cries similar to that of the goat, whine of the young pig, and wail of the wildcat have been reported (Blanton). By the end of the fourth month the ordinary infant has a sufficient repertoire of sounds to utter almost any word. From these original sounds words are very soon compounded, and real language begins. The development of language is closely correlated with general mental development, and in the earlier years word knowledge may be taken as a sign of general mental development.

Manipulation. Very soon after birth infants may throw their arms about and kick whenever any unusual stimulus is presented. Later, when the infant is well fed, he may move his arms and legs about at the mere pleasure at the activity. Small objects in their reach are thrown down, pulled apart, put together, and so forth. From these seemingly random movements coördinations may be made into complicated habits of skill. On the inherited structure depends the ease of learning. One person's hands have long facile fingers which, moving quickly and easily, may condition the expert fingering of a violin, while another's short stubby fingers may prevent this very thing. How is handedness related to manipulation? Some think that about 2 to 4 per cent of children are so left-handed that any change to the right hand may cause nervousness. Another investigator (Watson) has found no indication of right- or left-handedness in infants, and attributes all the differences between the right and the left hand to learning. He believes that if we started early enough, no harm would come in changing hands for the major kinds of work. On the other hand, it would seem that handedness is an inborn trait. An indication of this is the difficulty experienced in attempting to break it. Parents sometimes work *against* left-handedness from the first few years onward, but in spite of this, left-handedness persists.

Visual Exploration. From the first hours of life the eyes may follow a moving light and perhaps a moving object. As better control develops, the eyes fixate whatever attracts the infant's attention, and indeed on their wanderings frequently furnish new stimuli. Thus vocalization, manipulation, and visual exploration are of the greatest importance for the educative process.

III. Response to Others

Mastery.[1] The basis for unlearnedness of mastery is not so firmly laid as with the foregoing traits. It does not appear at birth, and it is probably complicated with habit formation, and yet when these are allowed for, there is still something essentially original about mastery. Children, during the first year, attempt to gain control of their environment. They pull or push the coverlets; they attempt to manipulate their toys and to manage people. The differences between persistence of infants in gaining their ends have been frequently marked. Some infants will work at a simple problem for several minutes, while others will give up quite soon. Moreover, these differences loom large in the individual members of the same family. Not only do infants and young children attempt to master their environment, but in another aspect of the same trait, they resist domination either by environment or by individuals. Attempt to remove a child's ball and he resists you with all his power, or let a not too large board obstruct the building of his house in the sand pile, and he, if rested, will attack it with a will. Indeed, some children will speed up their activities, strain, pull, and tug until the obstacle is removed. Others with a small amount of this impulse will have to be presented with a lesser obstacle before they put forth all of their energy. In the schoolroom, time and again we see evidences of this impulse. Attempts at mastery with some children seem half-hearted, while with others difficulties are attacked with great energy. One of the habits intertwined with this impulse is that of being stimulated to further work by past successes. If a child has had the work so carefully graded that he has rarely felt the sting of failure, he is spurred on to the very limit of his ability. On the other hand, there is nothing which dejects school children quite as much as failure. Once they get behind to any considerable extent, their mastery impulse is not definitely stimulated. They then try to express their personalities in another line. Thwarted in its impulse towards mastery in one direction, this impulse may appear in another. A large dull boy in Grade V hopelessly behind in his spelling and arithmetic asserts himself by knocking over the small boys, or else he plays the clown to get the attention of the pupils away from the books in which he fails and on to physical strength and antics in which he is successful. He thus becomes a nuisance in the classroom and most probably quite unhappy. The girl, in a similar situation, may wear gaily colored clothes, talk loudly, and call attention to her body, and gain the admiring attention of the class whose intellectual gyrations she cannot follow.

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[1] Mastery would properly fall either under II or III, since it appears as a response both to objects and to persons.

Much of the difficulty of discipline in a schoolroom is due directly to this same urge. The teacher in the pressure of daily work becomes irritable and speaks quite sharply to John, who is ordinarily a dependable pupil. The teacher says to him, "John, stand up and apologize for your conduct," and immediately a struggle for mastery has been raised. John says sullenly, "I won't." The teacher herself, angered at this obstruction to the carrying out of her commands, fumes around, threatens to have the boy sent to the principal's office, and possibly suspended. Similar cases happen hundreds of times. Sometimes the children perceive that the teacher may be easily irritated, and when thus angered does very little about it. They immediately begin to play pranks on her, and before long all discipline is gone. The impulse of mastery stands out clearly, and is one of the most important drives with which school-teachers have to deal. The old way sought to break down this impulse to mastery, but nowadays we hold it to be one of our most precious possessions to be directed along lines socially desirable.

Rivalry. When two individuals of about the same strength and intelligence attempt to master the one the other, we speak of it as rivalry. This impulse can be best directed by the rivalry with one's own past objective record, in which an individual's own past record becomes a rival as it were of his present one. Here we call to our aid objective tests. We measure the number of paragraphs of equal difficulty a pupil can read in five minutes, and then, three months later, he is given another form of the same test. He can now see objectively just how much he has improved. Another useful way to direct this impulse is by rivalry between groups. This fifth grade has a spelling match with that one; this algebra class challenges that one; this fifth grade challenges one in another school in arithmetic, and so on. It is one of the surprising events of life that by calling these individuals by so prosaic a name as "Reds" and those, "Blues," children can be induced to work when otherwise they could not. Rivalry between individuals will invariably appear without the aid of the teacher. Her greatest trouble is to prevent bitterness. These three boys want to be valedictorian of their class. The count is so close that the marks on the last examination will decide it—and you have a situation which may cause trouble.

Fighting. This trait frequently appears at the same time with mastery and rivalry. Indeed it may be possible that both mastery and rivalry are manifestations of the fighting instinct. Fighting may be regarded as the instinctive accompaniment of the emotion of anger. The infant hampered in his actions twists and squirms and turns red, probably increasing his blood pressure and stimulating his sympathetic nervous system, which in turn constricts the blood vessels, stimulates the adrenal glands, and furnishes us with the typical anger picture. This twisting, squirming, and later biting are the early manifestations of the fighting instinct. Like all other instincts it soon becomes conditioned, other stimuli arousing the same pattern which we have just described. There may also be modifications in the expression of this impulse, but all told the picture is well known. Boys manifest their fighting urge more overtly than girls. It may be stronger in boys. At any rate, crowded conditions on the playground, insufficient direction of play activities, and the congregating of larger and smaller boys on the same playground are usually potent stimuli to the arousal of this instinct. Probably any sort of hampering of one's activity may be a sufficient cause.

SUMMARY

Inherited behavior, then, is directly dependent upon inherited structure. It develops at the same time with the growth of the structure of the body. This latter is dependent upon the character of the chromosomes (bearers of heredity) for its development. All physical characteristics under normal conditions develop at a predetermined rate, i. e., a rate determined by the nature of the germ cells. As the structure develops, certain behavior patterns develop with it. The simplest of these we call reflexes;

the more complicated, instincts; the general capacity for modifiability and consequent learning, intelligence. Many of these reflexes, and at least one instinct (sucking), appear at birth. They are certainly inherited. Others appear later in the child's life without a great deal of coöperation from learning. For the explanation of these we have proposed the theory of maturation—or, that certain behavior patterns develop at different times. The inheritance of general intelligence or the capacity to learn, after reflexes, seems surest of being inherited, as it is a function of the modifiability of synapses.

This inherited nature, by the shifting of the situations, the changing of responses, or their combination, is changed into habits. Whether these habits shall be socially desirable or not depends upon the direction of these impulses. This direction is so different because original nature is frequently quite impulsive, and often conflicts with what is considered to be socially desirable. At any rate, the knowledge of these impulses puts us on our guard, and stimulates us to discover methods of dealing with them.

QUESTIONS AND EXERCISES

1. What is the nature of inheritance?
2. Just how is it possible for behavior patterns to be transmitted through the germ cells?
3. Show how heredity and environment interact in such a simple response as the grasping reflex.
4. Place upon a small card the list of instincts mentioned in this chapter. Make a trip to the playground and check those whose functioning you observe. Note particularly unusually intense manifestations of rivalry, mastery, sex, and manipulation.
5. If opportunity offers, careful records might be made of the actual reactions of infants during the first few days after birth. Maybe a friend will make the observations, leaving the interpretation to the student.

6. Name six or seven traits which appear at birth. Which one of these is admittedly an instinct, rather than a reflex? Why so considered?
7. What emotions are inherited? State the situations and responses in each case.
8. State and interpret the arguments in favor of the inheritance of general intelligence. Mention particularly the arguments from the correlations of twins and of sibs, and interpret carefully your results.
9. What is meant by the maturation of instincts? Is the evidence for maturation convincing? (Read Allport, *Social Psychology*, Chapter III.)
10. State and illustrate the criteria for determining the heritability of a trait. Which one of these seems the most valuable; which the least?
11. Prepare a talk of five minutes' length against the inheritance of mastery.
12. What does the increasing interest in books of adult fiction suggest concerning the type of collateral reading in high school during this period?
13. Should there be the same collateral reading for both sexes? Why?
14. Discuss the relation between mastery and school discipline.
15. How may rivalry be best used for motivating school work?
16. What school activities would be influenced by any limitation of sensitivities?
17. Complete the following statements:—
    a. Inheritance is the———relation between———generations. (See Thompson, *Heredity*.)
    b. The———are the bearers of heredity.
    c. Probably no trait ever appears without the coöperation of———and———.
    d. Reflexes are usually———than instincts; they are ———difficult to modify, and are over with quickly, while the instinct usually———.
    e. Emotions differ from instincts in having a———

reference rather than an———one. In many cases instincts and emotions appear———.

18. Mark the following statements true if you think the statement as a whole is true, and false if you think the statement as a whole is false.
    a. Acquired characters are inherited.
    b. It is known precisely just what occurs in maturation.
    c. The trait of rivalry may be used in motivation.
    d. The coefficient of correlation is a statistical device which may express the average relationship existing between two traits in the same group of individuals.
    e. Not more than 40 per cent of feeble-mindedness is inherited.
    f. Genius is probably not inherited.
    g. By the maturation of instincts we mean that traits appear later because of the general physical development plus learning.
    h. If a trait appears among Negroes, Chinese, Indians, Malays, Caucasian, it is certainly instinctive.
    i. The ear is responsive to sound vibrations between 16 and about 40,000.
    j. The eye is responsive to vibrations of the ether between 390 and 755 million million vibrations per second.

REFERENCES

References used in this chapter

Heredity and Environment

Jennings, H. S. "Heredity and Environment," *Scientific Monthly*, 1924, Vol. XIX, pp. 225–238.

Original Observations on Children

Blanton, Margaret Gray. "The Behavior of the Human Infant During the First Thirty Days of Life," *Psychological Review*, 1917, Vol. 24, pp. 456–483.

Shinn, Millicent W. "Notes on the Development of a Child," *University of California Studies*, Nos. 1–4. Nos. 1–2, 1893.

Quotation from Champneys on areolar tissue, Nos. 3–4, 1899, Vol. IV, p. 30. Quotation from Flechsig's *Gehirn und Seele* concerning functioning of lower cochlear nerve paths, Vol. IV, p. 30.

Watson, J. B. *Psychology from the Standpoint of a Behaviorist*, Second edition, On Emotions, Chapter VI, On Instincts, Chapter VII, 1924.

General Textbooks

Ladd, G. T., and Woodworth, R. S. *Elements of Physiological Psychology*, Revised edition, 1915.

Starch, Daniel. *Educational Psychology*, pp. 9–27, 1927.

Thorndike, E. L. *Educational Psychology*, Vols. I and III, 1913.

Mental Development

Baldwin, Bird T., and Stecher, Lorle I. *Mental Growth Curves of Normal and Superior Children*, University of Iowa Studies, 1922.

Gesell, Arnold. *The Mental Growth of the Pre-School Child*, Chapter 27, 1925.

Koffka, Kurt. *Growth of the Mind.* Reports the experiments of Edinger and Fisher on the infant without a cortex, pp. 56–57, 1925.

Woolley, Helen Thompson. Reported at the American Association of the Advancement of Science, Washington, 1924.

Maturation in Animals

Bird, Charles. "The Relative Importance of Maturation and Habit in the Development of an Instinct," *Pedagogical Seminary*, 1925, Vol. 32, pp. 68–91.

Breed, F. S., and Shepard, J. F. "Maturation and Use in the Development of an Instinct," *Journal of Animal Behavior*, 1913, Vol. III, pp. 274–285.

Spalding, D. A. "Instinct with Original Observations of Young Animals." Reprinted in *Popular Science Monthly* (now *Scientific Monthly*), June, 1902.

Yerkes, R. M., and Bloomfield, D. "Do Kittens Instinctively Kill Mice?" *Psychological Bulletin*, 1910, Vol. VII, p. 253ff.

Whipple, G. M. "Psychology and Hygiene of Adolescence," in Monroe's *Principles of Secondary Education*, p. 251, 1914.
Jordan, A. M. *Children's Interests in Reading*, Chapters II, III, IV, 1926.

Further Bibliography

Allport, F. H. *Social Psychology*, Chapter 3, 1924.
Bernard, L. L. *Instinct*, 1924.
Breed, F. S. "The Development of Certain Instincts and Habits in Chicks," *Behavior Monographs*, 1911, No. 1.
Craig, Wallace S. "Appetites and Aversions as Constituents of Instincts," *Biological Bulletin*, 1918, Vol. XXXIV, pp. 91–107.
Darwin, Charles. *Descent of Man*, 1871.
Dearborn, G. V. N. *Moto-Sensory Development. Observations on the First Three Years of a Child*, 1910.
Drever, James. *Instinct in Man*, 1923.
Dunlap, Knight. "The Foundations of Social Psychology," *Psychological Review*, 1923, Vol. XXX, p. 95.
Dunlap, Knight. "Are There Any Instincts?" *Journal of Abnormal Psychology*, 1919–1920, Vol. XIV, pp. 307–311.
Edman, Irwin. *Human Traits and their Social Significance*, Chapters 1–7, 1920.
Faris, Ellsworth. "Are Instincts Data or Hypotheses?" *American Journal of Sociology*, 1921, Vol. XXVII, pp. 184–196.
Gates, A. I. *Psychology for Students of Education*, Chapters VII and IX, 1923.
Gates, A. I. *Elementary Psychology*, Chapter V, 1925.
Gault, R. H. *Social Psychology: The Basis of Behavior Called Social*, Chapter 3, 1923.
Green, G. H. *Psychoanalysis in the Classroom*, Chapters I, II, III, IV, 1923.
Hall, Mrs. W. S. "The First Five Hundred Days of a Child's Life," *Child Study Monthly*, 1897, Vol. II, pp. 330–342, 394–407, 458–473, 522–537, 586–608.
Hunter, W. S. "Modification of Instincts from the Standpoint of Social Psychology," *Psychological Review*, 1920, Vol. XXVII, pp. 247–269.
James, William. *Psychology*, Vol. II, Chapter 24, 1890.

Johnson, Buford I. *Mental Growth of Children*, 1925.

Kuo, Z. Y. "How are Instincts Acquired?" *Psychological Review*, 1922, Vol. XXIX, pp. 344–365.

Kuo, Z. Y. "Giving up Instincts in Psychology," *Journal of Philosophy*, 1921, Vol. XVIII, pp. 648–664.

Kuo, Z. Y. "A Psychology without Heredity," *Psychological Review*, 1924, Vol. *31*, pp. 427–448.

McDougall, William. *Introduction to Social Psychology*, Chapters 2–4, Luce, 1908.

McDougall, William. *Outline of Psychology*, Chapter 5, 1923.

McDougall, William. "The Use and Abuse of Instinct in Social Psychology," *Journal of Abnormal and Social Psychology*, 1922, Vol. *16*, pp. 285–333.

Major, D. R. *First Steps in Mental Growth*, 1906.

Perez, B. *Les trois premières années de l'enfant.* Third edition, 1886.

Perez, B. *L'enfant de trois à sept ans*, 1888.

Pillsbury, W. B. *Psychology of Nationality and Internationalism*, Chapter 2, 1919.

Preyer, W. *Die Seele des Kindes*, 1881.
English Translation, *The Senses and the Will*, Part I, 1888, and *The Development of the Intellect*, Part II, 1889.

Reed, Ruth. "Changing Conceptions of the Maternal Instinct," *Journal of Abnormal and Social Psychology*, 1923, Vol. XVIII, pp. 78–87.

Smith, Stevenson, and Guthrie, Edwin R. *Psychology in Terms of Behavior*, 1921, pp. 82–84.

Stone, C. P. "The Congenital Sexual Behavior of the Young Male Albino Rat," *Journal of Comparative Psychology*, 1922, Vol. II, pp. 95–153.

Thomson, J. A. *Heredity*, 1908.

Tolman, E. C. "Can Instincts be Given up in Psychology?" *Journal of Abnormal and Social Psychology*, 1922–1923, Vol. XVII, pp. 139–152.

Tolman, E. C. "The Nature of Instinct," *Psychological Bulletin*, 1923, Vol. XX, pp. 200–218.

Tolman, E. C. "Instinct and Purpose," *Psychological Review*, 1920, Vol. XXVII, pp. 217–223.

Trotter, W. *Instinct of the Herd in Peace and War*, London, 1916.

Watson, John B. *Behavior: An Introduction to Comparative Psychology*, 1914.

Watson, John B. "What the Nursery has to Say About Instincts," *Pedagogical Seminary*, 1925, Vol. *32*, pp. 293–327.

Watson, John B. "Experimental Studies on the Growth of the Emotions," *ibid.*, pp. 328–348.

Watson, John B. "Recent Experiments on How We Lose and Change our Emotional Equipment," *ibid.*, pp. 349–371.

Wheeler, W. M. "On Instincts," *Journal of Abnormal and Social Psychology*, 1920, Vol. *15*, pp. 295–318.

Whitman, C. O. *Orthogenetic Evolution in Pigeons*, Vol. III, *The Behavior of Pigeons* (Ed. Harvey Carr), Carnegie Institute, Washington, D. C., Publications No. 257, 1919.

Woodworth, R. S. *Dynamic Psychology*, 1918.

Woodworth, R. S. "Review of Allport's *Social Psychology*," *Journal of Abnormal and Social Psychology*, 1925, Vol. XX, pp. 92–106.

Zigler, M. J. "Instincts and the Psychological Viewpoint," *Psychological Review*, 1923, Vol. XXX, pp. 447–460.

CHAPTER III

GENERAL PRINCIPLES OF LEARNING

Thus far the nature of educational psychology has been discussed. This subject has been found to gather up from the several fields of psychology all the threads bearing upon children and to center them on the growing child. In studying the development of the whole child the subject of inherited nature seemed the best place to begin. We have insisted that there are inherited neural pathways some of which appear at birth and others of which depend on the maturing of muscles and cortex, together with glands both duct and ductless. The maturation of neural and muscular patterns seemed a likely explanation of the appearance of certain original tendencies after the time of birth and much overt behavior fits in nicely with this theory of physiological maturing. These neuromuscular patterns make the process of learning possible.

Method of Description

In describing the process of learning we shall always attempt to keep in mind the situation (S) which arouses the action, the connection which is made, and the response (R) which comes as a result of the situation's acting upon an experiencing individual. "Situation" differs from the more usual word "Stimulus," in being more inclusive. In describing the knee jerk we say "If when the legs are crossed a light quick blow is made upon the great tendon just below the kneecap the foot of that leg will jerk upward." In this case the blow is thought of as a stimulus. Rarely ever in educational practice can human learning be described so exactly. More frequently, there are several coöperating stimuli which are grouped according to the school condition. We thus ask, "How much is 9 times 7?" This is a stimulus of course:—the sound of a voice impinges upon the ear of the pupil, or he may see the figures written upon the board. But it is more than a stimulus. It is a situation. There is the presence of the teacher, the pupil is in the schoolroom, he is surrounded by his fellows—all of which might be summarized as the schoolroom situation. The situation, then, is the combination of many stimuli usually into one whole. The *connection* usually written→consists of the changes in neural structure which have been made or are being made while joining the situation with the response. The *response* may be glandular or muscular. If muscular, the child says or writes 63, i. e., if the connection is well formed. The connection may not be well formed and the child chagrined beyond bearing bursts into tears, a glandular response.

Transition from Original Nature to Learning

The transition from original nature to learning is not abrupt. At times the association is so close that it is impossible to distinguish between them. This fact has been amply demonstrated in the realm of instincts. Is walking learned or inherited? Is imitation learned or inherited? Is the maternal impulse learned or inherited? In all these cases the "or" in the sentences had best be replaced by "and" for there is always some change in the inherited traits due to the coöperating environment. In walking, the down thrust of the legs seems to be inherited, but the coördination of many such simple reflex patterns into the walking pattern is learned. There are inherited some few tendencies for individuals to act as others act, but the general tendency to imitate seems to depend upon the perception of a movement or a position plus some expectancy of satisfaction, and is learned. In the case of the maternal instinct there are certain inherited connections which lead to pleasure at the touch of the newly born, but the whole group of partial activities is organized through learning into what is ordinarily called the maternal instinct. All action of mature individuals is learned to some extent and to a certain extent all is native. When we study original nature we mean, merely, the investigation of that part of human nature which seems to appear with only a little coöperation of the environment. The environment always coöperates to some extent.

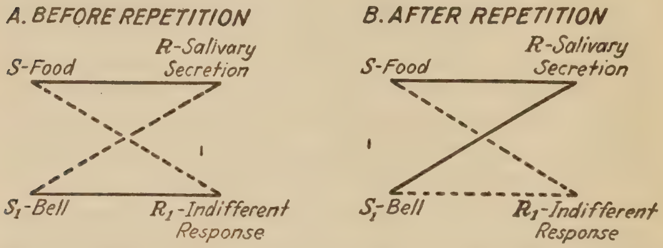
Learning may take place among all animals. Even in the animals which have no nervous systems there seems to be some learning. The paramœcium, a simple one-celled animal with no nervous system, may learn to double on himself when placed in a capillary tube. But the more complicated types of learning are dependent upon the presence of a nervous system. At birth there are a few patterns among the neurones which are ready to function, such as the sucking instinct, but the majority of the patterns which the adult uses is merely a possibility among the neurones. The neurone is the smallest unit of the nervous system. Each neurone is divided into three parts: the dendrites or receiving end; the cell body whose function is nutrition; and the axone or discharging end. All told there are about eleven thousand million neurones within the entire system and learning depends on the connections which are made between these very neurones. Before a new pattern can be formed there must be overcome certain resistances at the points of contact between neurones (the *synapses*). At the beginning of learning these resistances are quite high, but practice reduces them until the action is quick and accurate with hardly a suggestion of the difficulties traversed. This modifiability of the neurones, then, makes learning possible. Their multiplicity gives to man a great advantage over the lower animals in the variety of connections which are available. Man's neurones have more branches than have those of any other animal. Since each branch gives a new opportunity for a connection to be formed in the human being it is readily seen that he has millions of opportunities of forming patterns within the nervous system. Man is thus enabled to rise above other animals because of his superior organic structure. It thus is clear that the very capacity for learning, dependent as it is upon neural structure, is inherited.

Furthermore, *modifiability* and *sensitivity* of neurones together with their *capacity to conduct* at the rate of about 380 feet per second are inherited characteristics of their structure which are of great concern to students of the learning process. Upon the modifiability of neurones the retention of past experiences and the forming of new connections depend; while upon the sensitivity of the neurones depends the impression of the stimulus upon the organism; and upon their conductivity depends the connection of one part of the organism with another, or of a stimulus with its response. Indeed on these very qualities of the neurones depends the ease of forming connections, i. e., of learning. Some individuals find it extraordinarily easy to learn; others, not so easy; and others, still, learn with greater difficulty until we arrive at the idiot who is capable of learning only a few simple motor habits and of speaking a few short words. In the case of the idiot whose capacity for learning is so strikingly inferior there is known to be a smaller number of developed neurones, a larger number of undeveloped neurones (neuroblasts), a more irregular arrangement of them and a more imperfect internal structural development of those neurones which are apparently normal.

All learning is for these reasons directly dependent upon inherited structure. Without this inherited nature no learning takes place. Here, for example, is a person born blind. Visual experiences to him are utterly lacking. Color has no meaning whatever and brightness does not exist. Suppose one presents a red book to a blind person. He would ordinarily touch it or lift it, thus experiencing smoothness or roughness of texture, weight, size, etc., and to him "red" means these things. Did all red objects have smoothness, then "smoothness" would be to him the same as "red," or did they give forth only sounds or air pressures then these to him would be the qualities of the objects which gave them meaning. In brief, this blind person has something essentially lacking in his make-up for which no other inherited structure can substitute. Feeble-minded individuals who seem to be wanting in curiosity about objects in their environment furnish another illustration of this essential lack. It makes little difference to them what goes on near-by. While the bright child would be turning a thing over or taking it apart the feeble-minded one would be stupidly staring at it. To the feeble-minded child there has not been transmitted the type of nervous structure which possesses the normal amount of sensitivity or modifiability and no amount of training can ever take the place of this deficiency.

A. Simple Type of Learning

The Conditioned Response. The simplest type of learning is one in which by means of some very simple shifting of a situation or response,—an inherited connection is slightly changed. The classical experiment here was performed by Pavlov with a dog as subject. In this instance, an incision was made in the cheek of the dog through which a tube was attached directly to the salivary glands of the animal. The salivary secretions were lead through this tube and on to a delicate recording apparatus so that the precise amount of salivary secretion could be measured. The animal placed in a room was harnessed in and the conditions so arranged that no external stimuli (e. g., by means of an arranged mirror the experimenter was enabled to watch the dog's actions without the dog's being aware of his presence), except the controlled ones, could influence him. Under these conditions food was presented and the amount of saliva nicely measured. Then with the proffering of food a bell was rung. After several repetitions of these two situations together, the bell alone was sufficient to produce the salivary secretion. We thus have:



The heavy lines in A indicate that S was ordinarily connected with R, and S_1 with R_1 while after the repetition (B) S_1 could produce R without the presence of S. Furthermore, the broken lines represent possibilities of response. Pavlov called this process a Conditioned Reflex. This piece of investigation proved so stimulating that hundreds of similar experiments have been made both upon the lower animals and upon man, and the meaning and technique have been greatly broadened. In one case the bell was rung from 15 to 30 minutes before the food was presented. It was shown that, if the bell were rung just fifteen minutes before the food was presented to the dog, and if this process were repeated several times, then the salivary secretion would be produced just fifteen minutes after the bell rang. This has been called a *trace reflex* and can be produced in a dog up to an interval of 30 minutes. On the other hand and quite in contrast to the results just given, we find that if the conditioning S is given after the food is presented no results could be obtained from the ringing of the bell though the conditions were repeated a thousand times. We have then two procedures, "a and b," which result in a conditioned response and a third, "c" wherein no conditioning takes place:

a. Conditioning when the original S and the new S appear simultaneously.
b. Conditioning when the conditioning S appears before the original S.
c. No results when the conditioning S appears after the original S.[1]

An example of presenting the stimuli simultaneously is now given: A collie dog of the writer's acquaintance was muzzled for inoculation against rabies by tying a small clothesline around his mouth. Two injections were necessary for immunization. When the veterinarian was ready the second time, the owner with clothesline in hand, called the dog which came galloping up in his usual happy way but when he saw that little rope, his tail dropped, he stopped, slunk down, and began to tremble. We have here a clear case of conditioning.

S_1. Master and line: R_1 Playful activity, catches line in mouth.
S_2. Master and line. Tied up: R_2. Pain, slinking, fear.
After one experience,
S_1. Master and line: R_2. Slinking away.

In this instance the response is conditioned, i. e., a new type of response is attached to a stimulus which originally did not arouse this response at all. Watson's experiment whereby an infant learned to fear a rat is instructive in this connection. A young child eleven months old was presented with a rat towards which he showed no fear. Then for several days just as it was shown the rat a steel bar was struck immediately behind the infant. This harsh noise produced a fear reaction displayed by puckering the lips, throwing out the arms, and other characteristic reactions. This performance was repeated eight times. On the eighth time the child cried at the very sight of the rat. We now have:

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[1] For an excellent discussion of this whole matter see Perrin and Klein, *Psychology*, pp. 92–122.

S_1 Sight of rat: R_1 Reaching.
S_2 Sight of rat: accompanied by a harsh noise: R_2 Fear.
After eight repetitions,
S_1 Sight of rat: R_2 Fear reactions.

It is not hard to multiply examples of this simple type of learning. Hundreds of children learn to fear dogs in this very way. Some big friendly dog comes running up and knocks the child over and causes him some pain and much fear. Thereafter, the presence of this dog or of some dog like it is sufficient to set off this uncontrolled emotional reaction. In life, in general, this explanation of simple learning finds many applications. For instance, on one occasion when a boy, the writer while wearing fuzzy yarn gloves fell into a ditch and got considerably splashed. Among other things he remembers that the gloves were wet and that he put one hand, glove and all, into his mouth. Now he experienced such a feeling of all-overishness (kinæsthetic excitement) that he remembers it keenly even as he describes it. As a result he always feels aversion towards yarn gloves of a certain fuzziness.

We have then:
S_1, Yarn gloves: R_1, Indifferent response.
S_2, Yarn gloves, wet: R_2, Kinæsthetic shiver.
S_1, Yarn gloves: R_2, Kinæsthetic shiver.

Trace reflexes, or perhaps better, trace responses are not as frequent as those developed simultaneously and yet such type of simple learning appears in such a case as the ringing of a bell and the preparation for the meal. There are also known physiological preparations which appear such as increased salivary, gastric, and pancreatic secretion, and increased peristaltic action of the stomach. These responses are frequently conditioned by hearing the rattle of dishes or the ringing of a bell.

In these illustrations we have cases of simple learning. We shall now pass to the consideration of the general principles involved in learning. These explain how these simple connections such as those which have just been mentioned are combined into highly integrated habits.

B. More Complex Types of Learning

If we give to a young boy to be solved a puzzle with which he is entirely unfamiliar, he, if he is not too busy doing something else, will lift up the puzzle, observe it closely, twist it from side to side, maybe drop it on the table and in general move the parts about. One of these trials is successful. Provided the subject is intelligent, he will concentrate his second attempt on the manner in which he obtained his first successful solution and work along this line until he gets another solution. And thus the task is accomplished in less and less time until finally the solution comes quickly, accurately, with little or no fatigue, with more vigor and usually with some degree of pleasantness. Under these conditions, we say, he has learned the solution of the puzzle. Let us now examine this case carefully.

In the first place the foundations of learning consist in possibilities of responses. To solve this puzzle the individual must of necessity possess many possibilities of movement. If, for some reason, his arm and fingers had become paralyzed, thereby preventing their movements, the puzzle might remain forever unsolved.

There must in every case, then, be numerous possibilities of action from which one or more is to be chosen which carries out or completes the set in that direction. The correct response must be selected and stamped in and those not suitable must be eliminated. Finally, all the single steps must be integrated and organized into one smooth running whole. We have therefore to explain the process of:—

a. Set or adjustment
b. Selecting the correct response
c. Eliminating the incorrect response
d. The fixation of learned responses
e. Integrating the separate acts into a unified whole.

a. *Set or Adjustment.* Unless the individual desires to solve the puzzle no learning would take place, i. e., this set or adjustment towards the solution of the problems is of primary consideration. It selects the response and defines the meaning of correct, for "correct" means that the set is fulfilled, is carried through to its solution. Furthermore, the adjustment tendency helps to eliminate the response which does not fit in with it. There are, of course, other factors in this elimination process besides the set or adjustment, certainly other factors

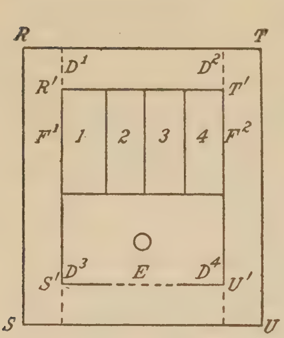

Fig. 1.—Maze used by Kuo (1922) in studying the elimination of various situations having different degrees of ill-adaptiveness. Groups of rats were trained under different conditions. In all cases food was placed either at F^1 or F^2. In one case the conditions were so arranged that the animals by going directly through compartment 1 and turning to the left at D^1 could arrive immediately at food. In 2 they would be caught and held; in 3 they would receive an electric shock, and in 4 they would go around through D^2, past U^1, through doors at U^1 and S^1 and finally to F^1 which was the long route. With the other groups, 4 might be the short route and 1 the long one, or 3, the short route and 2 the long one so that the position of the route could have no relation to the final pathway chosen. At O preliminary training was had to acquaint the animals with the urge of food. Importance is attached to giving the animals the right sort of set to begin with.

which determine the order of elimination of ill-adaptive responses, but the set or adjustment plays the dominating rôle. Consider, for example, in the experiment of Kuo the care which the experimenter took in order to get the right set from the beginning, for he gave the animals preliminary experience with food at 0 (see Figure 1) before he began their regular course of training. The influence of the mental sets of rivalry, of the exposure of the results to the learner of praise and blame, upon the learning process are discussed in Chapter IV. The correct mental set towards the solution of an immediate problem plays an important part in the successful learning of school subjects (Chapter VI).

b. *Selecting the Correct Response.* In the above-mentioned experiment the pathways in general were eliminated in the order of their being ill-adapted to the fulfillment of the adjustment, the most ill-adaptive being eliminated first, the next most ill-adaptive next, etc., until the most adaptive one was finally selected and all the others eliminated (except that two rats persisted in running the long pathway). In brief, the pathway in which the rats were stimulated with electricity was the first to be eliminated, that one in which the rats were caught and held was next in order, then the long one was last to be eliminated. Set or adjustment plays, then, an important part in the selection and elimination of responses but there are other coöperating factors.

In addition to the set towards the completion of a series of acts there are other factors which coöperate. What else is it that does the selecting?[1] Some have urged that the successful act merely appeared more times than the others and hence, by the law of use or frequency, was selected. Recent experimental evidence, however, seems to contradict this hypothesis directly. In the experiment of Kuo quoted above, the experimenter concludes: "Many animals learned to select a correct path not only because of recency or frequency, or both, but in spite of them." An animal thus may have tried the long pathway time after time, but once having discovered the short pathway may thereafter have entered only the short pathway.

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[1] For a critical discussion of the selective factors in learning, see Kuo, Z. Y., "The Nature of Unsuccessful Acts and the Order of Their Elimination," *Journal of Comparative Psychology*, 1922, Vol. *2*, pp. 1–27, and Perrin and Klein, *Psychology*, pp. 218–243.

In spite of recent criticisms of the law of effect, the writer believes that it is more fundamental than any other theory of the explanation of the selection of responses. The law may be stated simply: Whenever a connection between a situation and response is satisfying the connection tends to be repeated and conversely, whenever a connection made between a stimulus and response is annoying the tendency is for that connection not to be repeated.

Satisfaction seems to be the selecting factor and annoyance the eliminating one. Whenever a response is accompanied by a feeling of satisfaction it tends to be selected and repeated. Whenever a response is accompanied by annoyance it tends not to be either selected or repeated. Satisfaction may be defined physiologically as the heightened tonus of an organism probably resulting in an increased metabolism due to the successful completion of an adjustment; annoyance, as a depressed tonus of the organism producing a decreased metabolism which is due to inability to complete an adjustment. In using this method of explanation for the events of Kuo's experiments, we would say that the rats selected the pathways which were most satisfying and least annoying and in that order. In addition to frequency and the law of effect some psychologists have postulated *intensity* as being the selective factor, the response which is most intense being strengthened the greatest amount. But intense situations may act in opposite directions: an animal receiving intense pain in one pathway withdraws from it, while one receiving an intense food stimulation advances. It would thus seem that intensity may produce either an advancing or a retreating response.

The selecting factors, therefore, are the set and the law of effect which in most cases do the work. But there seem to be some difficulties with the law of effect. One of these appears in the consideration of the retention of experience, commonly called memory, for, while pleasant events in general are most easily remembered and the annoying things forgotten (Hollingworth, H. L.), as when more mature individuals speak of the good old days and sing of the old oaken bucket that hung in the well, there are cases of extremely disagreeable events being vividly remembered. There is no great amount of experimental investigation on this point, but common observation is sufficient to justify it. Thus one remembers extremely well the time he ran out of money in a great city, or the terrible automobile accident which befell him. Another difficulty appears in the consideration of such a stimulus as pain or fear which may cause an animal to avoid a situation. For example, a spirited horse was frightened at a white rosebush gleaming in the moonlight and thereafter shied each time he passed that place. It would appear that he had learned this response just as truly as he had learned to whinny when the farm bell rang at noon. Now a negative response may be as truly learned as a positive one. All these cases seem to need the principle of intensity to explain them and hence satisfaction and annoyance are postulated merely as *selective* and *not* as *fixating factors.*

c. *Elimination of the Unsuccessful Act.* In the solution of a puzzle many movements are made which are just as promptly eliminated and may never reappear. This phenomenon requires explanation as much as does the selection of the successful one. In the first place these unsuccessful actions do not lead to the solution of the problem, the fulfillment of the mental set. They are therefore more or less annoying, and the affective tone produces an avoiding response. In the second place, this response leads to neglect or disuse which in almost every case weakens the connection between S and R. We have therefore two good causes for the elimination of the unsuccessful responses, (1) annoyance and (2) disuse.

d. *The Fixation of Connections.* After the response has been selected the next important step is the strengthening of the connection to such an extent that the response follows the situation quickly, accurately, and with little fatigue. There are at least two factors here: (1) intensity, and (2) exercise or repetition. Intensity or vividness plays a great part in the process of fixation. One vivid experience with a fact may be sufficient to cause that fact to be remembered for all time. Frequently the intensity is enhanced by some emotional tone. One individual on having an accident near a bridge finds thereafter that he has automatically retarded the speed of his car on approaching any sort of bridge. We say "a burnt child fears the fire," for one horrible intense experience seems sufficient to form that connection for all time. "I never shall forget that day" is the common introduction to some story about an intense experience. The writer remembers clearly the day and circumstances when he studied that magnificent passage from Milton's *Paradise Lost*, "With grave aspect he arose and in his rising seemed a pillar of state," etc. While the description was of Beelzebub, parts of the passage seemed descriptive of some great men he had recently seen. The teacher's reading of it was superb and to this day the experience is well remembered.

The Law of Exercise is the second factor. This explanatory principle is easy to understand, for it means merely that other things being equal when a situation (S) is connected with a response (R) the response follows the situation more quickly, more easily, and with less fatigue. If in the beginning of the formation of the connection fatigue is felt, it tends to diminish as the connection is more perfectly formed. Each of us who has learned typewriting after maturity remembers how in the beginning some letters, such as "e," were easily learned because they were exercised so much more frequently, but even after considerable progress had been made there would occur occasional periods characterized by hunting here and there for the lost key. At first, if some one was reading aloud the material to be copied on the typewriter, the person writing could remember only small units of the sentence while he would have to inquire after the remainder more than once. Furthermore, there was considerable bodily tension, e. g., one's back hurt even after half an hour's writing, and after an hour of such exertion one felt as if he had done a hard day's work. Gradually, more facility is achieved, muscles are relaxed and series of several letters may be run off without any great amount of effort. Sometimes indeed one looks to find a whole word written as if the mechanism had run itself with little conscious participation. When the material to be copied is read aloud one now may remember a whole sentence without asking that any part of it be repeated.

But there are curious exceptions to this principle. The author on one occasion attempted to classify literally thousands of books, the names of which children had given in answer to the query, "What books do you like best?" Some of the books occurred so frequently that numbers were used for them. After one book had occurred with the same number for fifty or more times it would seem that the law of exercise would have functioned sufficiently for the name of the book to be connected with the number. On the contrary there were scarcely half a dozen numbers that were connected closely enough with the proper books so that the name of the book would be remembered when the number was called. There is no doubt but that the author could have memorized twenty or thirty numbers with their appropriate books in half an hour had this been the task assigned. Again, a little boy four years old learned "am it?" for "is it?" and repeated this for hundreds of times, but one day rather suddenly adopted the correct expression. Rats after having run many times on a long way to the food box may after one run through a shorter path, adopt this one permanently and never run the long way again (Kuo). Kittens after trying many ways to get out of a box may settle upon the latch to be raised or the button to be turned with little adjustment to any other feature of the situation. There are, too, some cases which seem directly opposed to this principle. An individual living near a railroad may at first hear every train, but in course of time repetition or exercise seems to weaken the very process of hearing so that the sound may be neglected. In this case, to be sure, the repetition of the sound does not increase the reaction of the organism to it. A prominent teacher in a university admits that he has not learned his morning prayers though he must have read them five thousand times.

e. *The Process of Integration and Organization of Habits.* Learning consists of more than of simply forming connections between situations and responses. These connections themselves must be organized into an integrated habit. Thus in the solution of complex puzzles many responses may be organized into one simple habit which is performed quickly and accurately. Probably the best understood process of the integration of habits is the process of receiving messages in the field of telegraphy. In the study of this process Bryan and Harter analyzed the Receiving curve into the Word curve, the Letter curve, and the Connected Discourse curve (Figure 2). They showed that the Connected Discourse curve in its course did not follow that of either the word curve or the letter curve, since the first mentioned, after the subjects had practiced for a long time, took a sudden rise. Now the authors undertook to explain this rise by postulating a hierarchy of habits by which they meant

Receiving Rates of Student John Shaw, Brookville, Ind.

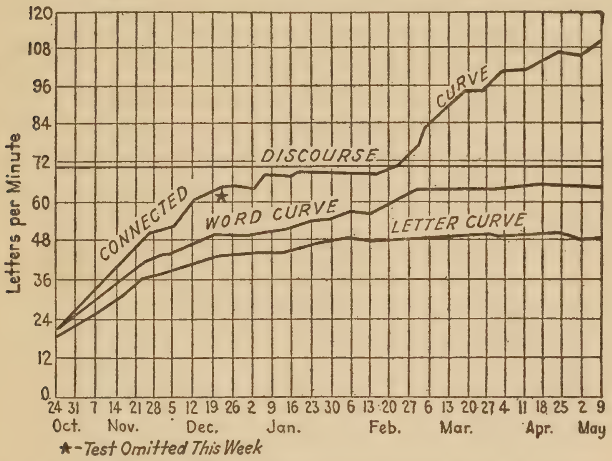

FIG. 2.—An analyzed receiving curve in the field of telegraphy. Observe particularly the second rise of the "connected discourse" curve when it passes the standard line at the level of about seventy-two letters per minute and also the rather rapid rise at first of all three curves. (Bryan and Harter, 1899.)

that a newly organized habit had been formed into which the small habits fitted.

"A hierarchy of habits may be described in this way: (1) There is a certain number of habits which are elementary constituents of all other habits within the hierarchy. (2) There are habits of a higher order which, embracing the lower as elements, are themselves in turn elements of higher habits, and so on. (3) A habit of any order, when thoroughly acquired, has physiological and, if conscious, psychological unity. The habits of lower order which are its elements tend to lose themselves in it, and it tends to lose itself in the habits of higher order when it appears as an element therein." [1] These authors have also shown that the speed of receiving telegraphic messages depended upon the number of simple elements which were combined into one single habit and not on the speed of recognition of the single unit. Good receivers would read from six to ten words behind the instrument taking the meaning of the message and not the simple units out of which the meaning was built.

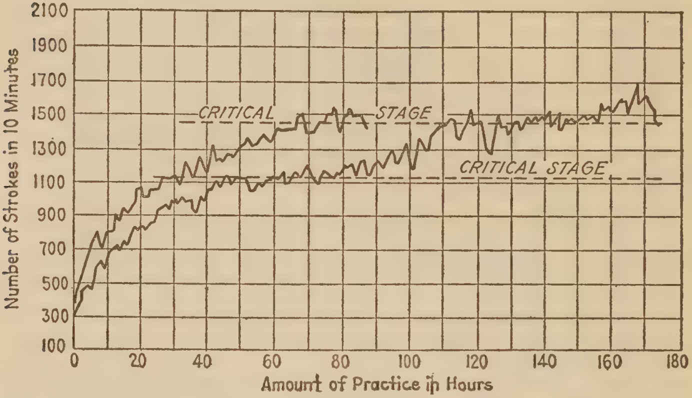

FIG. 3.—Improvement made in typewriting by the sight method. Note (a) the rather rapid rise at first, (b) the daily variations producing the small undulations in the curve's direction and (c) the critical stages which appear at times of the continuation of a period of little, if any, improvement. (Book, *Learning to Typewrite*, 1925.)[2]

It must be emphasized here that this is an advanced stage of learning which could never have been reached without the mastery of the simple elements. The chain would also have been broken had one unit of it fallen into disuse. Figure 3 sets forth the learning curve for typewriting which illustrates with a different function a similar type of learning curve.

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[1] Bryan and Harter, 1899.

[2] Book, W. F. *Learning to Typewrite*, p. 270, 1925. Used by special permission of the Gregg Publishing Co.

The exact process of integration of simple habits into more complex ones is not understood. Certain steps in the process are *undoubtedly omitted* and certain other processes so fused that several stimuli are responded to as if they were only one. This fusion of stimuli is made possible by some of the simpler connections being made automatic so that they practically run themselves. The processes of habit integration are nicely illustrated in reading, arithmetic, and handwriting, which we shall discuss in another chapter.

The Learning Curve

The use of the learning curve in picturing the progress of individual learners has already been demonstrated in our consideration of the learning of telegraphy and the learning of typewriting. From these two studies it is clear that the learning curve is a graphical representation of the connections which are being formed between situations and responses. Suppose that we take a simple case and build up a learning curve. In this case the subjects are asked to think of each

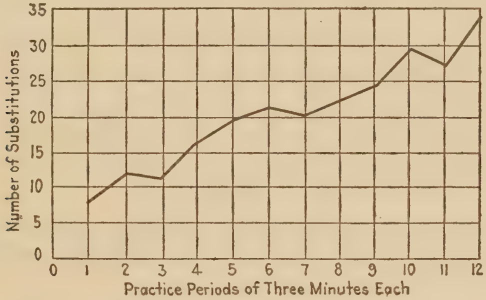

Fig. 4.—Number of substitutions of letters midway between numbers when each number represented a letter of the alphabet.

letter of the alphabet as having a number, then the problem, consists in placing the proper letter between two numbers, e. g., "What letter occurs midway between the sixth and the tenth letter?" etc. Three minutes are given in each practice period.[1] In one case an individual scored as follows: first practice period, 8; second, 12; third, 11; fourth, 16; fifth, 19; sixth, 21; seventh, 20; eighth, 22; ninth, 24; tenth, 29; eleventh, 27; and twelfth, 34. The procedure followed in constructing the graph is quite simple. We first lay off on the base line convenient intervals equal in length. Then number them to include the total number of trials. The vertical line also we divide into equal units and let these divisions be equivalent to any number of convenient units. In locating the points, a line through which constitutes the learning curve, we take the score on the first practice period and locate it above the figure 1 and at the point where the horizontal line representing that score crosses the vertical line representing the "1." In this instance the point is eight units above 1. In a similar manner, we proceed with each score at each trial. Then join the points thus discovered by a straight line. We then have a learning curve characterized by a steady upward rise with only a few exceptions to this general trend. A second method of graphing the same results is to compute the time for the substitution of each letter. The curve will in this case have a downward trend as learning increases, indicating a decrease in time.

Below are given two learning curves of differing nature: (a) Figure 5 is a sample of improvement in rate of reading and (b), Figure 6 is a curve of ideational learning. These two curves may well be compared with Bryan and Harter's curves of telegraphy (Figure 2) and Book's curves of typewriting. In general we see that the telegraphy and typewriting curves rise rapidly at first, then more slowly. On the other hand, the curve for improvement in silent reading rises slowly at first then more rapidly, while the substituting of letters for median numbers (Figure 6) has a steady upward trend. These three or four curves are sufficient to indicate that each mental function has a curve peculiar to it and that there are few typical curves of learning.

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[1] See Exercise 7 at end of chapter.

In many of the curves there is a rather rapid rise in the earlier stages of habit formation. This is probably due to interest, and to the fact that easier bonds are to be formed first. After these phenomena, there is sometimes a more or less flat portion of the curve. (See Figures 2 and 3.) These periods of no visible improvement, called *plateaus*, have been explained in three ways: (a) A period in which the simpler habits are being made more automatic. Once this

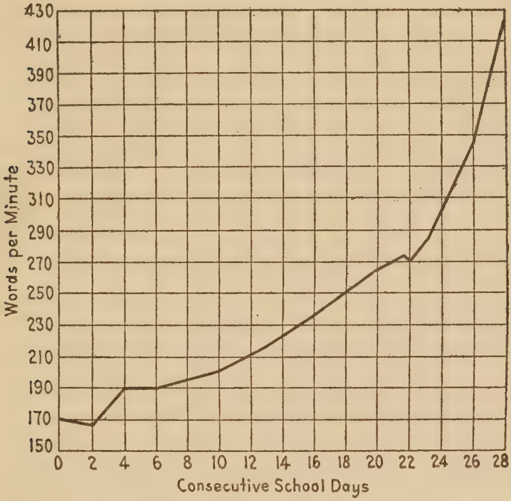

FIG. 5.—Progress in rate of silent reading. Nineteen pupils, Grade VI. (After O'Brien, 1921.)[1]

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[1] O'Brien, J. A. *Silent Reading*, Graph XVI, p. 221, 1921. The Macmillan Company. Reprinted by permission.

perfection of bonds is attained the individual may later be able to organize them into a hierarchy of habits. (b) Lack of interest. Book reported that some of his pupils said that they preferred to do anything else rather than do the one thing in which they were engaged. This loss of interest seemed to him a very significant factor in the process of learning. (c) Plateaus are caused by the student's arriving at a more difficult stage in the learning process. It is entirely conceivable that any one of these three might at times be the cause of the period of no visible improvement, i. e., of the plateau. In many learning curves the individual finally

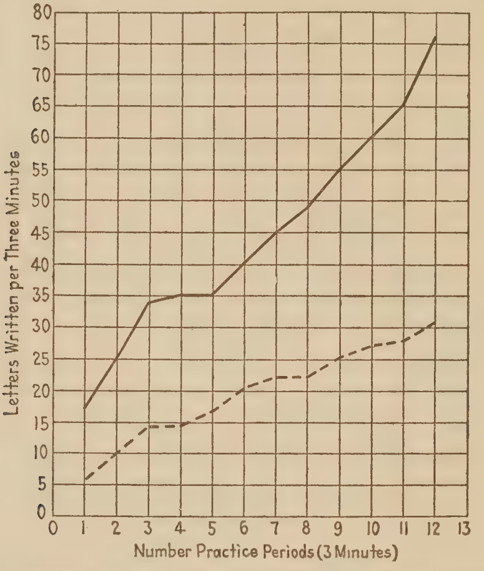


FIG. 6.—Improvement in identifying the letters of the alphabet when each letter is numbered consecutively and the task is to think of the letter occurring midway between two figures such as 4–8. See exercise 7. Top line is one individual; the bottom represents the average of the class.

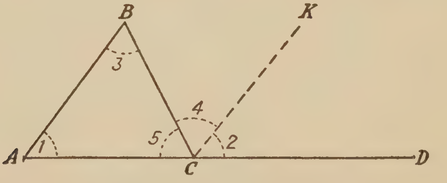
breaks through this dead level of learning and his learning curve takes a second rise. This second rise is frequently due to the formation of a hierarchy of habits which have already been explained. The learning curve then reflects very delicately the changes which take place in the process of learning.

Application of These Laws to the More Complicated Types of Learning

Particularly do these principles of learning, those of set, selection, elimination, fixation, and integration, stand us in good stead when we attempt to explain the more complicated types of learning. A child attempts to solve a problem in arithmetic. The more it resembles his own life's experiences the more industriously will he be "*set*" towards its solution. A secondary adjustment towards its solution will be made by the conditions of the problem. These sets determine largely the process of selection and of elimination. That individual, of course, will have the greatest chance of getting the answer who has the largest number of possible solutions. The fixation will consist largely in the understanding of the principle involved and the intensity and satisfaction which this knowledge brings. Finally there must be brought about the organization of these principles into a scheme for further application of the principle involved. Let us take, for example, the following problem:

"There were $25,000 to be distributed among four brothers. John received 27%, Louis 24%, Samuel 22%, and Robert the remainder. How much did Robert receive?" If this problem is solved there will have to be brought to bear upon it many facts already learned; percentage, the use of decimals, the meaning of the word "remainder," some idea of adding the percentages given and subtracting them from a hundred and multiplying 25,000 by the remainder, or some other bonds will have to be thought up if the correct answer is to be obtained. In any case the habits which have been acquired will have to assist in solving the problem. In most cases the child who has the largest number of these possible solutions ready at hand will be the one to obtain the correct answer. Selection of the proper R is determined by the set and the satisfaction occurring from the fulfillment of the set. Fixation occurs in using the principle involved in several similar situations while integration comes in so perfecting the learning process that much short-circuiting in the process may take place so that the whole process is easily held in mind and carried through to a successful solution in much less time than at first. Another good illustration of the laws of learning appears in the solution of a problem in geometry.

"The interior angles of a triangle are equal to two right angles" is the problem to be solved. It usually occurs after the discussion concerned with parallel lines cut by a transversal. One ordinarily proceeds by drawing the triangle, A B C.



Now rarely if ever is the solution gained directly. One may, for example, drop a perpendicular at B but on attempting to prove the two triangles equal, arrive at no conclusion. Or he may extend AC to D. This may or may not help him, depending on whether he sees the further step of drawing from C a line parallel to AB. In case this is done he proceeds rather easily, for then, angle 1 is equal to angle 2, for his previously learned information about parallel lines being cut by a transversal comes to his aid. Furthermore, if his mind works toward a solution, he casts around for additional information, possibly about parallel lines. Yes!

angle 3 equals angle 4 because they are alternate-interior angles. Here again, the laws of learning have been at work resulting in useful connections. Then his argument may proceed: Angle 5 is equal to itself. He may even stall here if he does not remember to put together the fact that angles 1, 5, 3, equal angles 5, 4, 2, which are equal to a straight angle or two right angles. Whatever the result might be, it was arrived at because (1) there was a mental set towards the solution of the problem, (2) certain responses were chosen because they fulfilled the set and others eliminated because they did not, (3) the fixation of the correct responses through intensity and repetition, and (4) the integration and organization of the material learned so that if the problem were repeated, there might be an organization and integration of habits which would shorten the entire process. It is clear, therefore, that if an individual solves a new problem in geometry, makes some new discovery in chemistry, or invents a lever to move the world, it is explainable by means of the laws of learning.

RETENTION

At almost the very instant when learning ceases, forgetting begins. In several experiments with nonsense syllables as short a period as 20 minutes was sufficient to bring about some loss in the efficiency of recall. There may be exceptions to the rule but certainly, in general, there is a decrease in the efficiency of S→R Connections as time goes on. The amount of retention among differing types of functions is our only concern.

Below appears a graph showing examples of the amount of retention in material of a diverse nature.

In Figure 7 we have graphed the percentage of the material retained at differing periods of time. Forgetting goes on apace with each type of function but in differing amounts. The most rapid process of forgetting or the least amount of retention appears in nonsense syllables, the greatest amount of retention in Latin words and phrases. There are several factors which condition the amount of retention.

Among these conditioning factors, meaning stands out clearly as being of first importance. Now meaning is dependent upon the number of relations in which a fact appears.

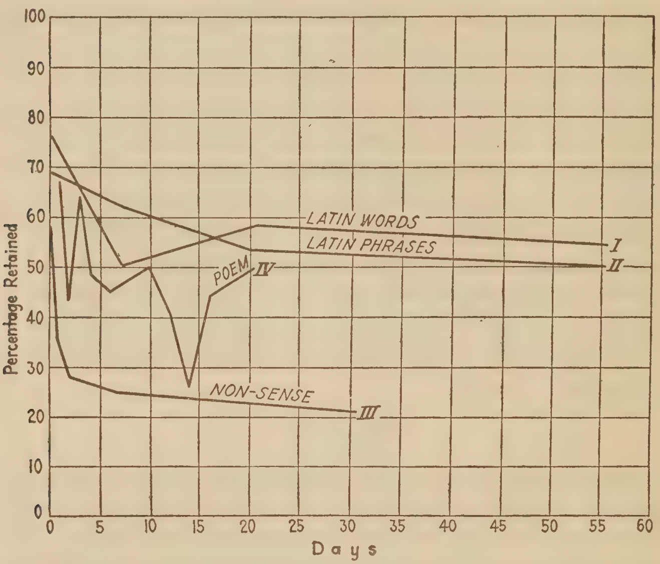


FIG. 7.—Percentage of retention in differing kinds of material. No. I is an average curve of the retention of 160 Latin words by 30 first year high school pupils. No. II is also an average curve of the retention of 40 Latin phrases by first year high school pupils (Anderson, J. P., 1926). No. III is Ebbinghaus's curve of retention of nonsense material. No. IV is Magneff's retention curve for the material of a poem.

The larger the number of associations the more evident the meaning. The meaning also depends upon the organization of experience. If one, for example, can place the action of this little stream here in the same category as the actions of great rivers, if its origin and subsequent course is similar to that of most other streams, it is then possible to place this fact in its proper relation with other facts and thus to understand its meaning better. There have been many schemes advanced for improvement in the retention of experience or, as it is sometimes called, memory. Mnemonic devices, rhymed first letters, clever associations, all have been tried, but in the long run most of these fail, because these schemes tend to reinstate experiences devoid of meaning. On the other hand, it has been clearly demonstrated that thousands of single bits of experience may be easily and accurately recalled, provided they have taken their place in a well-organized and systematized whole. It is this meaningful organization of experience which is the greatest aid to retention.

The amount of retention depends also on the number of repetitions in that, as a general rule, the larger the number of repetitions the greater the amount retained or the less forgotten. It has been shown experimentally that the first repetition is the most important, probably because the individual pays closer attention. For each succeeding repetition there is an added amount of retention up to a certain number after which the further repetitions have little effect. Some experimenters, even, find a law of diminishing returns whereby each successive repetition produces less and less effect upon the percentage retained. Moreover, unless there is some reaction during the repetition it may effect retention almost not at all. In the next place the intensity of the reaction, as has been already shown, affects directly the repetition which is made and the consequent amount of retention. The fourth factor is the distribution of the repetitions. As we shall see in the chapter on How to Study those repetitions which appear at certain optimum intervals, rather than those that are bunched, have the most potent effect. Sometimes rhythm affects the retention process in that ideas learned in rhyme are retained for a longer period of time than otherwise.

There seem to be some differences in retention due to the personality of the learner. As children grow older they retain a greater amount of their experiences. A good illustration of this fact appears in immediate memory for haphazard numbers. The child of three years can remember on the average three haphazard numbers when presented orally; the four year old child can remember four such numbers; the seven year old child, five; the ten year old child, six; the fourteen year old child, seven; and the superior adult, eight. Similar results have appeared when meaningful material was used. Experiments show that girls retain slightly more than boys at almost all ages. The proper distribution of repetitions to prevent such rapid forgetting will appear in Chapter VI.

Learning to Generalize

The principles of set, selection, elimination, fixation, and integration offer adequate explanation of the learning of school subjects and are fundamental. But there are times when it is very difficult for the pupil to distinguish clearly the precise situation to which he is supposed to attach the response or even the response which he is to make. Particularly is this the case when generalizations are to be made or abstractions to be formed, the elements of which are embedded in concrete experiences. Thorndike has given us the ways in which the formation of generalizations and abstractions are facilitated. These are detailed below.

1. *Piecemeal Examination.* By this is meant a careful examination of the components of the whole. In teaching, for example, the present tense of the Latin word "vocare" to a beginner in Latin he might be asked to observe closely the way the word is spelled, calling attention to the ending "-are" and to the fact that the first person of the verb nor-

mally ends in "o," the second person drops the "o" and adds "-as." The plural, too, is like the singular in the third person except that it ends in "-ant" instead of "-at."

2. *Vary the Concomitants.* By varying the concomitants is meant the varying of the nonessential parts keeping at all times the essential element constant. In teaching further the present tense of this verb, we could now proceed with the present tense of other verbs such as properare, portare, etc. The present tense always remains present but it appears now as habito, habitas, habitat, then as propero, properas, properat, and again as porto, portas, portat.

3. *Contrast.* Another helpful way to make the generalization stand out clearly is by means of contrast. Voco, vocas, vocat, might be contrasted with the English, I call, you call, he calls. In such a contrast, the slight amount of inflection in English and the larger amount in Latin might be called to the pupil's attention. Thus, gradually at first and suddenly at times, full realization of the present tense with its total significance dawns upon the pupil so that he not only recognizes the present tense of the first conjugation when he sees it but can form it from any verb of the first conjugation whenever it is necessary for him to do so. Those three principles of generalization have wide application, illustrations of which appear below.

The problem might be, for example, the attempt to understand the principles which determine the growth of a great city. The child is first led to examine carefully the conditions surrounding the growth of a great city such as New York or Chicago. In this procedure, he notes particularly such things as transportation, water supply, surrounding territory, etc., and arrives at some working principles. This may be labeled piecemeal examination. The next procedure is to have him study several other cities which have some of the advantages he has listed and have not others. The pupil thus begins to arrive at an understanding of the essential conditions. This process may be called varying the concomitants. Finally the teacher discovers places on the map which enjoy many of these advantages but where no cities have grown up and helps the child to discover why this condition prevails, the presentation of opposites. From this procedure there has grown up in the child's understanding certain fundamental conditions which cause the rise of great cities. By means of the process described these conditions have been carefully defined and delimited and made usable.

This process of generalizing experience stands out as one of the most important principles to be applied to the school subjects. Consider such an error of speech as appears in the following sentence: "I am glad of you going." This particular error arises because of an incomplete analysis of the meaning of the noun which has not extended to the meaning of the verbal noun. Or again, many teachers of physics have to teach over the simple application of algebra to such an equation as $V=\frac{gt^2}{2}$, which needs to be solved for t. Now had the pupil generalized this knowledge of equations, this extra teaching would not have needed to be done. In this case, the difficulty may have occurred because the customary algebra letters are a, b, c, x, y, z but not V, g, or t and these latter seem strange and unfamiliar.

The failure to generalize a series of experiences probably comes in a majority of cases because of a failure to vary the concomitants sufficiently for the general principle to be certainly apparent. One of the striking differences between a good teacher and a poor teacher appears in the capacity of the former to draw from a rich experience, material to present a topic in a variety of settings and in the failure of the latter to do more than repeat the topic in the same setting. The latter procedure killeth; the former, maketh alive.

SUMMARY

Learning consists of forming connections between situations and responses. It depends upon the inheritance of neural patterns. Man surpasses other animals in the number and complexity of these patterns. The multitude of possibilities of connection prevents many of the patterns from being definite at birth so that man is able to form thousands of connections through the process of learning. The simplest changes we have called conditioning which appear both when the conditioning and unconditioned stimuli are presented simultaneously and when the unconditioned stimulus follows the conditioning stimulus.

The principles of set, selection, elimination, fixation, and integration seem adequate to explain all phases of more complex learning. They are applicable both to motor and to ideational learning, and to simple or complex learning. Probably these principles are sufficient to account for all types of learning. All the principles are not needed in every case, for example, in many functions organization and integration cannot appear because of the simplicity of the connection, but these principles are amply able to explain most learning. The generalization of experience, we have seen, occurs through piecemeal examination, through varying the concomitants and through presentation of elements with their opposites. And finally, the amount retained seems somewhat conditioned by the age and personality of the individual, but most of all by the meaning, repetition, intensity, and distribution of the repetitions in the case of the material learned.

QUESTIONS AND EXERCISES

1. Discuss the physiological basis of learning.
2. Distinguish sharply between stimulus and situation.
3. Explain the necessity of the physiological basis in the formation of any connection.

4. Why is it so difficult to separate learned nature from original nature?
5. Give three further illustrations of simple conditioning.
6. Show how the laws of learning apply to the solution of new problems.
7. Practice twelve periods of three minutes each upon the following experiment. Keep a careful record of your results. Plot your learning curve and compare it with the average of the class and with those given in the text.

THE EXPERIMENT

INSTRUCTIONS

Imagine that each letter of the alphabet is numbered in order from 1 to 26. Now without writing down the vocabulary think what letter occurs between the first and third letter. This letter is B. Below there is a series of two numbers with a hyphen between. You are to think of the letter represented by the first number, and then the one represented by the last number, and then of the letter occurring midway between the two. This last letter is the one to write down. For example, in the first pair we have 4–8. The fourth letter is D, the eighth letter is H. And the letter occurring midway between them is F and so we write "1. F." In the same way for the second, we think of the letter occurring midway between the sixth and the tenth letter and write that letter for number 2. The subject proceeds as far as he can before the time is up.

SUGGESTIONS

1. Write the numbers 1.
2.
3.
etc., before you start.

2. Begin at the first at the beginning of each three-minute period.

3. In case the subject does all the fifty before the three minutes are up he may fold under what he has just finished and start over again from the first.

The Practice Material

1. 4–8
2. 6–10
3. 10–14
4. 13–17
5. 20–24
6. 12–16
7. 17–21
8. 11–15
9. 19–23
10. 9–13
11. 15–19
12. 7–11
13. 16–20
14. 8–12
15. 14–18
16. 7–13
17. 18–22
18. 11–17
19. 10–16
20. 17–23
21. 9–15
22. 13–19
23. 15–21
24. 12–18
25. 8–14
26. 6–12
27. 14–20
28. 16–22
29. 4–10
30. 5–11
31. 3–9
32. 15–23
33. 7–15
34. 12–20
35. 17–25
36. 4–12
37. 13–21
38. 8–16
39. 6–14
40. 10–18
41. 18–26
42. 5–13
43. 16–24
44. 3–11
45. 9–17
46. 5–13
47. 2–10
48. 14–22
49. 11–19
50. 1–9

8. Get the average of the class scores in "7," and plot your scores on the same graph with the average.
9. What differences are there between individual curve and the class curve? Which is more irregular? Why?
10. Write an introspective account of your mental process in learning. Did you use your fingers?
11. How much did you improve between the average of the first three practice periods and the average of the last three? How does this improvement compare with that in word knowledge, in reading, in addition? What explanation do you offer for the differences if there are any?
12. State and illustrate each of the general principles of learning.
13. How is it possible to shift an attitude or set to a new situation?
14. How is it possible to generalize ideas? Why is this so difficult to do? Plan out six illustrations in teaching the meaning of the noun. Gates speaks of "Interpenetration of verbal instruction and experience." How would that apply in learning the meaning of the noun?

REFERENCES

Book, W. F. *The Psychology of Skill*, 1925.

Book, W. F. *Learning to Typewrite*, 1925.

Bryan, W. L., and Harter, Noble, "Studies in the Telegraphic Language. The Acquisition of a Hierarchy of Habits," *Psychological Review*, 1899, Vol. *4*, pp. 345–375.

Freeman, F. N. *How Children Learn*, Chapters VIII and IX, 1917.

Gates, A. I. *Psychology for Students of Education*, Chapters X and XI, 1923.

Kuo, Z. Y. "The Nature of Unsuccessful Acts and Their Order of Elimination in Animal Learning," *Journal Comparative Psychology*, 1922, Vol. *2*, pp. 1–27.

Meek, L. H. *Learning and Retention in Young Children*, 1925.

Perrin, F. A. C., and Klein, D. B. *Psychology*, Chapter V, 1926.

Pillsbury, W. B. *Education as the Psychologist Sees It*, Chapter VII, 1925.

Pyle, W. H. *The Psychology of Learning*, Chapters I and II, 1921.

Starch, D. S. *Educational Psychology*, Chapters VIII, IX, X, and XI, 1920 and 1927.

Thorndike, E. L. *Educational Psychology* (Briefer Course), Chapters X, XI, and XII, 1914.

Watson, J. B. *Psychology from the Standpoint of a Behaviorist*, Chapters VIII and IX, 1924.

Woodworth, R. S. *Psychology*, Chapter XIII, 1921.

CHAPTER IV

CONDITIONS OF LEARNING

Physiological, Psychological, Educational

In the last chapter the general principles of learning have been set forth, while the present one seeks to show some characteristics of the learner which condition to a certain extent the functioning of these laws. One of the most necessary conditions of learning is the correct mental set. This chapter is devoted to the task of setting forth, among other things, the ways and means whereby a desirable mental set may be developed.

I. *Physiological Conditions of Learning.* A sick child, an undernourished child, a child with such poor eyesight that his images are clouded or blurred, most certainly could not be expected to learn so successfully as the same child with these disabilities removed or corrected. Among the common types of physical conditions which influence learning in a harmful manner we have selected those of vision, hearing, adenoids and tonsils, hookworm, and ventilation for special treatment. By the word "physiological" as used in this connection, we mean minor bodily ailments whose influence on the learning process is not so apparent, rather than the more serious bodily conditions such as typhoid fever whose influence upon the learning process is universally recognized.

Defects of vision are very prevalent. Probably the greatest danger in defects of vision arises from a failure to detect their presence. They may be present for years and even cause numerous frontal and occipital headaches, inflammation of the eyes, eyelids, or conjunctiva, etc., before their presence is discovered. The most common mechanical defects of vision are myopia (nearsightedness), hypermetropia (farsightedness), and astigmatism (blurring of vision due to incorrect refraction of the lens or cornea). Furthermore, there are difficulties due to the lack of the proper adjustment of muscles. One of these is called strabismus (cross-eyedness) which is characterized either by a turning of both eyes or of one eye, inward, and of one or both eyes outward. Another defect for which there is no known remedy is color blindness. Some attribute this defect to the failure of the retinal substance to reach the final stage in its development. The most common type is red-green color blindness, characterized by an inability to distinguish between these two important colors. It appears about three times as often in boys as in girls. These defects of the eyes are sufficiently numerous in school children to warrant our serious consideration. It has been reported by competent authorities that from 15 to 35 per cent of school children have their vision seriously enough impaired to be in need of medical attention. Now myopia is the result of an eyeball which is too long so that the focus of the rays of light is in front of the usual point (the fovea centralis) and thus when the image comes to a focus it is blurred. An individual so afflicted brings his eyes nearer the book than normal in his attempt to correct the incorrect focusing.

These defective conditions arise from numerous causes. The causes of myopia are difficult to discover. Some authorities say that the total condition is due to inheritance, while others attribute it to the hard usage of the eyes. The environmentalists (the latter) cite as evidence the great increase of nearsightedness in the German higher schools (the Gymnasien) in which the requirements of the course of study are very rigid. In these institutions the percentage myopic during the first years of the Gymnasien was 12.5, during the last of the six years 55.8,[1] and while these figures are not conclusive they buttress up others of a like nature. Hard usage undoubtedly makes for myopia. Hypermetropia, or farsightedness, is caused by an eyeball which is too short so that the image comes to a focus behind the retina. Signs of farsightedness appear in the pupil's moving out his book further from the eyes than normal when he attempts to read. Astigmatism is due to the irregularity of curvature of the lens or the cornea, or to both, so that some parts of the object are brought to a focus in different planes from the others, thus producing blurring in some parts of the image. Strabismus or cross-eyedness is due to the irregularity of pull of some of the six pairs of eye muscles. The need of the discovery and immediate correction of these defects is too patent for further mention.

Similarly, there are defects of hearing but they have not been so clearly differentiated as in the case of vision. We have in this field no such well-defined names as myopia or astigmatism, but simply defects of hearing. The percentage of children with defective hearing ordinarily reported has varied all the way from about 2 per cent to 12 per cent. Further data are unnecessary to show the enormous number of children who are suffering from some sort of sensory defect which hinders them from getting the clearest impression possible from the objects presented.

Adenoids, tonsils, decayed teeth, malnutrition, feelings of drowsiness, headaches, and the rest of the vast multitude of physical ailments exert a great influence on the general progress of the pupil in learning although the amount and direction of their influence has not been determined by reliable experimental procedures. I shall report a few studies as samples of the types of investigations which have been conducted.

The first study was an investigation (Margaret Cobb

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[1] From Cohn. Quoted in Whipple's *Manual*, Vol. I, p. 171.

Rogers) to determine the effect of adenoids and tonsils upon the intelligence quotients of young people. Tests were given just before the operation for the removal of adenoids and tonsils and again six months later. The final test was given twelve months after the operation. There was found no tendency for the I.Q. to change more in the tonsil-adenoid group than in the control group. In short, intelligence as measured by the best available tests (Stanford-Binet) did not seem to be affected by the removal of adenoids and tonsils. When we turn to the effect of the removal of these upon achievement in school the case is different. In the investigation here (MacPhail) it was found after a careful study, in which were eliminated all pupils who had no records during the previous ten months, that there was a small amount of improvement during the first period of ten months, a much greater percentage of improvement during the second ten months, and universal improvement during the third period of ten months. His table shows these facts rather clearly:

TABLE III

Table Showing when Improvement Began after Adenoids and Tonsils had been Removed
Per Cent of Cases Showing Improvement
(MacPhail)

	Period 1 First 10 months	*Period 2 Second 10 months*	*Period 3 Third 10 months*
Based on 31 cases	32.2		
Based on 18 cases	33.3	66.6	
Based on 11 cases	36.3	63.5	100
Based on all groups	33.9	65.	100

The effect of hookworm disease on mental development is malignant. In an extensive inquiry into the causes and consequences of this disease by the Rockefeller Foundation under the direction of E. K. Strong, rather striking conclusions were drawn in regard to the effect of this disease on mental growth. Children were carefully tested with such tests as opposites, logical memory, and the Binet-Simon at intervals after they had been cured. The results are stated by the author as follows: "The figures show, then, that hookworm disease unmistakably affects mental development. Treatment alleviates this condition to some extent but it does not, immediately at least, permit the child to gain as he would if he had not had the disease and the figures apparently further show that prolonged infection may produce prolonged effects upon mentality—effects from which the individual may never recover." These results have been checked rather carefully by two recent investigators (Smillie and Spencer) who used more precise technique, particularly in determining the number of hookworms present. Their findings have tended to corroborate the earlier results. For example, the heavy hookworm infestation was generally accompanied by a low I.Q., the average I.Q. being 76 on the Otis test. The children with a moderate amount of hookworm infestation had an average I.Q. of 84, while those with light cases were normal mentally.

Another study had as its problem the differential effect of stale, warm, and moist air upon both the learning capacity and the learning inclination (Thorndike, Chapman, McCall). The subjects were placed in a room where the conditions of moisture, temperature, motion, and intake of air could be artificially controlled. Mental tests such as hard opposites, and mental multiplication were used. The changes in temperature, humidity, or air intake had no appreciable effect either on the amount of the functions learned or on their accuracy. Moreover, even when opportunity was given for relaxation from work in such lighter occupations as conversations or reading a current novel or in the complete cessation of mental activities in sleep, there seemed to be no more relaxation or complete cessation of work either in a hot moist room or one in which the air was in motion or motionless than in one in which the best hygienic conditions prevailed, i. e., when the temperature was 68 degrees F., the moisture 50 per cent, and when 45 cu. ft. of fresh air per person, entered each minute. This experiment has any number of possible errors. In the first place 86 degrees F. would hardly be called uncomfortable "summer heat" even in New York. In the second place, "four hours a day for five consecutive days" is mild compared with fourteen hours a day or even twenty-four hours a day for two weeks. On the other hand, we have nothing but opinion based on introspection and limited observation to place against these carefully conducted experiments. The opinion of the author, however, is that if one should infer from this study that varying amounts of fresh, moist, or warm air had no effect upon the learning process, such an inference would be erroneous.

The upshot of these matters—of myopia, hypermetropia, and strabismus; of adenoids and tonsils, and hookworm, and to a lesser degree of ventilation,—is clear. Teachers must ever be on the watch for signs of maladjustments, of defects in eyes and ears, of insufficient air. They must help to get parents interested in taking their children to experts and in carrying out the recommendations of these experts once they have been obtained. It has been amply demonstrated, too, that these deficiencies bear directly upon the learning process and that they furnish countless irritants distracting the child from the task at hand even if they do not have the more permanent effect upon the neurones of the cortex resulting in a decrease in intelligence. Health, then, becomes not only a thing to be desired for purposes of general physical well-being but also because it facilitates the formation of bonds made manifest in the acquisition of motor, informational, and emotional habits.

II. *Psychological Conditions of Learning.* There is no sharp distinction between physiological and psychological conditions of improvement. By the strictest definition these two always occur together in that every mental experience has a physiological conditioning. In the realm of feelings and interests this is peculiarly true. Attitudes of mind, interests, and emotions are closely tied up with bodily conditions so that one can hardly speak of the one without mentioning the other. It is only, then, for purposes of study that we now come to close quarters with those phases of experience which are ordinarily called mental. In the study of our first topic-mental set and attitudes—it is peculiarly fitting, that this relation be kept in mind. In many cases for "mental set" we could with just as much truth say "organic set." "Set" always has two aspects: the one, the neuromuscular adjustment to the new situation; the other, the accompanying consciousness. In simple acts involving mostly nerves and muscles the neuromuscular adjustment is a large part of the set, but in more complicated types of set involving anticipatory consciousness and lasting over considerable periods of time, consciousness is the dominant element. Any description of set which eliminates either of these two aspects is incomplete and partial.

Mental Set or Attitude. Mental set may be best explained by considering several illustrations. One places upon the blackboard $\begin{array}{c}9\\ \underline{7}\end{array}$ and asks the class for an answer. Now some will answer 16; others, 2; and still others, 63, depending upon the mental set of the moment. In an experiment recently performed, involving two columns of numbers, the first column of numbers was arranged in pairs, each pair having between the numbers a plus sign indicating that the numbers were to be added. The second column, quite near the first, had similar pairs but with this difference, the sign was minus, indicating subtraction. In many cases the subjects *added* almost half of the second column before they discovered the minus sign. The set or adjustment of adding had been so strong that it carried over to the next column. In life we frequently find sets so firmly established that they are changed only with the greatest difficulty. Thus Miss Downey finds that for some people it is very difficult to disguise their handwriting so that it could not be easily recognized as theirs. They seem to carry a load or set. Many regard this ability to shift quickly from one mental set to another as one of the signs of intelligent action.

In the classroom we find numerous examples of attitudes. One student comes to a class because he feels that this subject prepares him for his life work. He is confident of this fact and appears the first day, alert, and ready to take notes. Another, just as capable, has been unable to fill out his schedule as he desires. Conflicts have occurred and after a long conference with his dean he takes this same course. He sees no value in it for him, arrives at class late with not even a pencil, not to mention a notebook or text. The instructor assigns the same work to be done, and lectures in the same manner to both. The difference in results is due to the mental set or attitude. Of course, the skillful teacher may change the attitude of the second student but this takes time and radically different marks may be earned on the course because of this difference in mental set. This matter of mental set, adjustment, or attitude is evidently well worth further consideration.

Some Quantitative Aspects of Mental Set or Adjustment. Many teachers actually at work with instructing children have felt that there has always been a gain whenever the subject enlisted the whole active mind (sometimes called the will) of the pupil. Only recently has this hypothesis been subjected to experimental analysis. So definite and clear-cut have these findings been, with such a large number of subjects, and carried out under such carefully controlled conditions that I shall quote from it at length.

The study (Book and Norvell, 1922), was undertaken to discover the effect of knowledge of results of learning and satisfaction thereat upon the learning process. Its subjects were 124 juniors and seniors—48 men and 76 women—at Indiana University. The experiment was carried on at the regular laboratory hours and was much like the usual laboratory experiments. The procedure was to subject the groups of students to radically different sorts of situations and to measure the effect of this change in situation on the amount of work done. In carrying out this general plan, the two sets of situations may be referred to as the "stimulus situation" and the "control situation."

The students in the motivated group were stimulated as follows:—

a. The students kept before them the results of their previous work.
b. They were urged to improve their scores, were told when they did not improve.
c. When they failed to improve, it was explained to them that the very best in class had such period of no improvement and that the next time they would certainly do better.
d. They were asked to keep a sharp lookout for short cuts and other methods of improving their scores.

In the second group of situations, "the Control," the students were urged to do their best but after each practice period parts of the sheets of paper on which their results were recorded were carefully folded under so that the results were not visible. Moreover, the students were asked to forget their previous scores. (In some cases the students afterwards reported that they simply could not keep their minds off their past records.)

The material to be learned consisted of a simple test of speed of muscular movement, the writing of "a's"; a simple subtraction test; the crossing out of Spanish words; and mental multiplication. In the learning of each of these mental functions a group of students would be influenced by the "stimulus" situation for a part of their learning and would then come under the "control" situation. The incentives listed under "stimulus" not only affected the learning of the group as a whole but also the learning of every single student in the experiment. Individuals who were making little, if any, improvement would suddenly begin to improve, when the stimuli were presented, and contrariwise, those who had been improving ceased almost immediately when the stimuli were withdrawn.

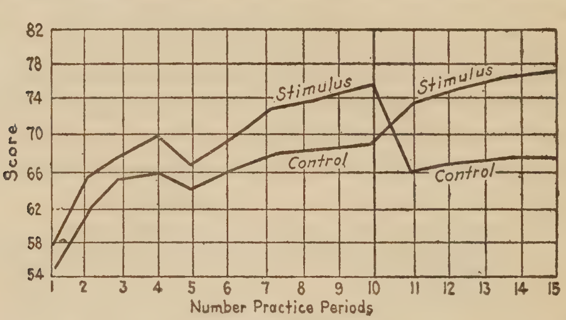

Fig. 8.—The effect of reporting to each individual the record of his previous practice period. The function thus influenced was the writing of as many legible "a's" as possible during a thirty-second period. The Stimulus group during the first ten practice periods stood out conspicuously ahead of the Control group. After the tenth practice period, the Control group became the Stimulus group and vice versa. The Stimulus group, now *not* permitted to study their scores, began to lose ground at once; whereas the Control group, being permitted to study their records, responded immediately. (Book and Norvell, 1922.)

Figure 8 (Book and Norvell) illustrates the idea exactly. Here were these students writing "a's" at a great rate stimulated by their own results and by the encouragement and stimulation of the experimenter, but almost at the moment of the withdrawal of these stimuli (indicated on the second vertical line) there was a drop in the improvement. On the other hand, the control group now becoming stimulated begins to improve until it surpasses the group who were once quite far ahead. We see here two decisive effects of the stimuli: first, when the stimuli are present the learning improves; second, when the stimuli are withdrawn the learning decreases. Figure 9 shows the estimated effect of the knowledge of results on the process of learning.

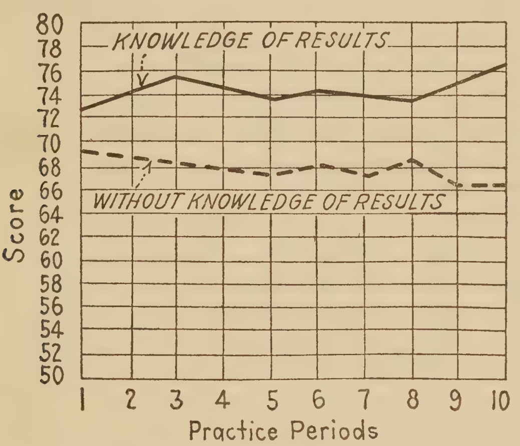

FIG. 9.—Typical practice curves showing effect upon the score of interest in improvement when one hundred practices were given alternately with a knowledge of the score (I) and without a knowledge of the score (II). (Book and Norvell, 1922.)

Similar results have been obtained more recently (Ross, 1927) in an investigation of the effect of information on improvement in making tallies. The subjects were 59 college students of whom 28 were freshmen and 31 upper classmen. There were three groups: (a) those who had full knowledge of their progress, (b) those who had partial knowledge, and (c) those who had no knowledge. Their improvement was in the order named, "a" gaining from 35 to 57; "b" gaining from 35 to 54; and "c" from 35 to 51 in the practice periods. One important difference between this study and Book and Norvell's appeared: the informed group continued to improve after the stimulus of information was withdrawn. This experiment in spite of this minor difference in results offers confirmatory support to the findings of Book and Norvell relative to the measurable increase in improvement when the subjects are informed of their progress.

Praise and Reproof as Incentives. Praise and reproof are undoubtedly among the most powerful drives whose stimulation comes from without the individual. They are the most commonly used of all incentives and play a very important rôle in the direction and modification of human affairs. School children because their habits have not become settled and because of their lack of experience are highly susceptible to this form of human direction. They are most likely to be influenced by these forces if they hold in high esteem the persons who are praising or reproving. This explains why high school pupils at a certain age are so impervious to the praise and blame of their parents, for, at this time, pupils have come to value more the opinions of those of their own group than the opinions of their parents.

Which is of greater directive value, praise or blame? Recently an investigator (Hurlock) has attacked this problem directly. In her first investigation the effect of praise and reproof in raising the scores of an intelligence test, there seemed to be little difference between them as incentives. In the second investigation, which consisted of testing the effects of praise and blame over a period of time, the results were quite different. In this second investigation in which about 106 children in Grades IV and VI participated, the attempt was made to measure carefully the effect of praise and reproof acting over a week's time. The testing material consisted of addition tests made up of six three-place numbers which were modifications of Courtis's Research Tests in arithmetic. The pupils on the basis of this test were divided into four equivalent groups: the Reproved group, the Praised group, the Ignored group, and the Control group. All save the Control group remained in the same room but the Control group went into another room. Each day before the test papers were given out, the members of the Praised group were marched up before the class and roundly praised both for the improvement they had made and for their superiority to other members of the class. They were encouraged to do better and to avoid any careless mistakes. The Reproved group were then called out and its members severely reproved for the large number of careless mistakes, and in general for their inferiority to other members of the class. The Ignored group heard these proceedings but their names were not mentioned either in praise or blame. We have therefore the Praised group whose name is descriptive of its treatment; the Control group which went on with its work as usual; the Reproved group whose sins both of omission and commission had been severely censured, and finally the Ignored group, the very name of which is sufficiently explanatory.

Figure 10 sets forth more clearly than words the effect of the various incentives. It will be noted that the groups began together. The Reproved group and the Praised group are exactly the same on the second day, but after this they diverge rapidly. Praise seems to be cumulative in its results, while reproof soon loses its effect. To be ignored has some effect on human activity. One might surmise that the pupils of the Ignored group must have been anxiously awaiting their turn to be praised or scolded. Certain features of the curve seemed to bear out this hypothesis for there is more improvement between the first and second days or just after the first day of praise and reproof than at any other time. This improvement, however, is followed by a falling off of work done by this group.

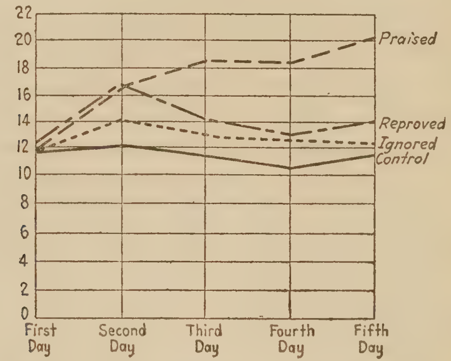

FIG. 10.—Effect of various types of incentives on the ability of children in Grades IV and VI to add six three-place numbers. Practice periods fifteen minutes daily. (From data of Elizabeth Hurlock, 1925.)

There were some interesting by-products of this investigation. All types were absolutely more influenced by praise than by any other incentive, still there were interesting relative differences. Girls, for example, were more affected by praise than boys; while with boys, reproof was the greater incentive. Praise also had the greatest effect on children of inferior intelligence, next on those of average ability, and least on those of superior intelligence. Reproof struck the superior children hardest. The praised and reproved groups were the only ones who improved in accuracy.

Rivalry between Groups. The Jesuits, whose schools were models for their times and whose story of mild discipline has come down to us, were famous for their use of rivalry. They divided the class up into two groups and skillfully played the one against the other. Each individual, too, had another of about equal ability and industry as his own particular rival. This individual rivalry seemed to be the vicious part of the scheme. It seems to the writer that properly controlled rivalry is a legitimate means of stimulating interest when other means have failed. The writer, at one time teaching Latin to a group of high school pupils in a small town, almost despaired of ever getting the pupils to learn the various forms of the verbs. One day he thought a change of procedure might be helpful and thus he announced the plan, selected the two captains, and let them choose sides. It was planned to conduct the next recitation after the manner of a spelling match. The teacher was to give the questions and one child was to answer, but if he failed he was to sit down and an individual on the other side was to try it. Thus by alternating from one side to the other as in spelling matches the lines would grow shorter and shorter. The first day did not go so well because the rules of the game had not been satisfactorily worked out. But the next day the fighting spirit was aroused and the writer has never seen a more spirited recitation. The interest kept up for nearly a week and the writer found that many, if not all, of the forms were learned.

Rivalry with one's own past record is undoubtedly the finest type of rivalry. Objective tests lend themselves admirably to the prosecution of this idea. In reading, spelling, composition, handwriting, and arithmetic there are tests in sufficient numbers to test a child monthly. From these test scores graphs may be drawn which show the progress of each individual pupil so that the child himself can recognize immediately whether or not he is above or below his previous record.

This type of graph is easy to make. Indeed, the child may be taught to construct his own graph. He thus gets accustomed to a sort of objective evaluation of his own resources.

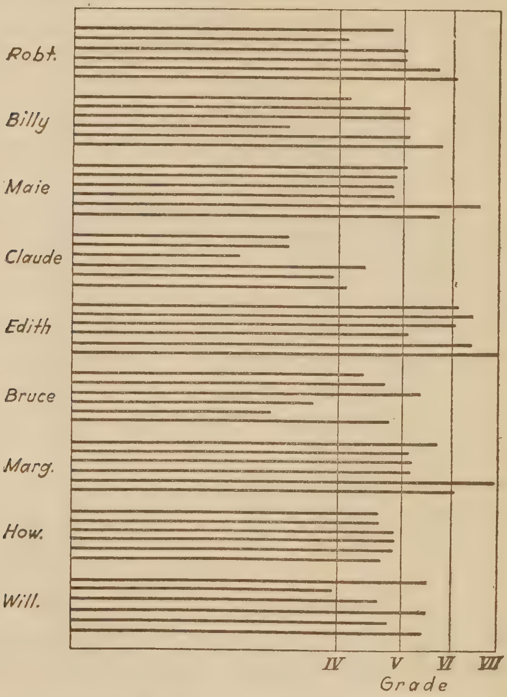

FIG. 11.—Each line represents one pupil's score in one test of the Thorndike-McCall Reading Test. Data from a fifth grade. Tests given monthly. Top line is the first test which was given in November. Each child was tested six times.

Figure 11 is an illustration using actual data. Such an accurate determination of the pupil's position in his reading enables him to know exactly where he stands and what improvement he is making from month to month. It has the advantage of giving him objective facts, not subjective ones. Moreover, by drawing on the graph the grade standards it is easily determinable just where the pupil belongs. He can see and know whether he is up to standard or not. Improvement now becomes a coöperative undertaking between the pupil and the teacher in order to get the pupil up to his standard. He has then an objective goal clearly before him and the objective record of his improvement. With these facts before them most pupils will more nearly listen to the recommendations of the teacher to read some interesting book, or give a more attentive eye to the phrase flashing or to other types of material for improving the speed and comprehension in reading.

But all these incentives are from the outside. They are superimposed. Real abiding interest, self-running, can be had only in making the material of the school significant for the child. This can be done by studying carefully the life interests of children and providing in the schoolroom some opportunity for the expression of them. Reproof soon loses its force, and even rivalry becomes dull. Praise undoubtedly after a while palls on one, but such an interest as a girl gets in reading *Little Women*, or a boy in reading *Treasure Island* is apt to abide. It is this abiding interest in their subjects of instruction which we most wish for our children.

Interest. Much has been done in recent years to catch and hold the interest of children in their school and in their subjects of instruction. Many educators have come to the conclusion that to send a child out from school heartily disliking history, or English, so that he feels that never again will he look at a book on these subjects or indeed any book, is a pedagogical crime. They have set about to create an atmosphere pleasant to the child. Now pleasantness ordinarily arises out of attaching a response possibly unpleasant in itself, or at least neutral, to a situation which normally is attached to a pleasant response. For example, such a problem as: "Find the cost of one bushel of potatoes, three pounds of carrots, and twenty pounds of flour" would certainly not arouse much interest unless perchance the pupils were playing house. But such a problem as "Grandpa gave William three dollars for Christmas. Could William buy a pair of roller skates, a top, and some marbles and have any money at all left to buy sister Sue a Christmas present?" might come very nearly being a life situation. A child trying to write compositions misspells at each attempt one or two words which from time to time are written down in a notebook. Finally a list of these accumulates and may be used for a spelling lesson. This procedure is more significant to the child than a list of words dictated from a spelling book although these latter may be necessary. A trip to a near-by hill and stream followed by making a clay model of them may catch more the impulse of children to activity and give them more precise knowledge of the effects of water upon land and the meaning of the action of rivers than a similar amount of time given to the reading of verbal descriptions of the Amazon. A trip to a local shrine of historical interest may leave a more lasting impression of the majesty of history than reading the accounts of many battles. All of the more prosaic types of education are, of course, important, but whenever possible the facts significant from the standpoint of the child should be introduced. One further example, this time from the high school field, is fitting. Well-prepared science teachers have been able to catch some of the wonders of modern science and to use them to arouse the imaginations of the pupils. The radio, great hydroelectric enterprises, aëroplanes, and suchlike stand ready at hand. Some teachers have even been successful in focusing the work of a term around a project, such as the gas engine. If one has mastered the principles involved in a gas engine he has done a good year's work in physics. In brief, the attempt is made to study the life situations, especially those which affect the growing boy or girl, then to bring into the schoolroom those which can legitimately be used without cheapening the educational process. A long time ago, as we now reckon time, John Dewey voiced these sentiments in urging the breaking down of the intellectual barriers between the school and the home and between the school and the community so that the child would not be educated in isolation from these vital institutions.

Interest in Reading. Probably in no field is interest more important than in the reading of books. It is that abiding interest in the masterpieces of literature which is so greatly desired. Suppose that a boy about thirteen years old has recommended to him *Treasure Island.* Immediately his attention is caught by the stirring events of this tale of adventure and his interest is held throughout the work. This event may have two results: In the first place, he finds that there are indeed books to his liking and thus he may seek for other books of a similar nature; in the second place, his attitude towards his teacher's judgment of books may change so that now the youth may inquire of the teacher for other books. In recent years there have been several investigations of the types of books liked, of selections and poems preferred, and of magazines chosen.

In the one of these investigations with which the author is most familiar, censuses were made of the interests of about 5,000 children in books and magazines. The questions asked were:—

I. 1. Will you kindly write down for me the name of the book you like best of all the books you have ever read?

2. Will you write down for me the name of the book you like next best of all the books you have ever read?
3. Will you write down for me the name of the book you like next best and next best of all the books you have ever read until you have written five books arranged in the order of your preference?

II. 1. Will you write down for me the name of the magazine you like best of all the magazines you have ever read?
2. Will you write down for me the name of the magazine that you like next best of all the magazines you have ever read?
3. Will you write down for me the name of the magazine you like next best of all the magazines you have ever read so that altogether you have written three magazines arranged in the order of your preference?

With the records from these questions together with the child's age, sex, and grade in hand, the books and magazines were listed and classified according to age and in a later investigation also according to grade. Furthermore, these results were checked up by a personal investigation, during a period of three months, of the reading habits of children in the public libraries in and around New York City. The two phases of the study revealed marked similarity of results.

In the first place, with boys adventure stood out ahead of any other type of literature; with girls, fiction. The following table based on the questionnaire reveals not only the amount of interest in each type but also the change of interest from one age-group to another.

TABLE IV

Percentage Table Indicating the Relative Proportion of Books Chosen in Each Class

(105 Pupils Ages 19–23 Omitted in This Table)

Boys		59	253	846	283
Girls		87	336	1195	414
Ages		9–11	12–13	14–16	17–18
Adult Fiction	B.	4	6	18	30
	G.	15	33	45	58
Juvenile Fiction	B.	27	19	11	9
	G.	67	44	30	13
Adventure	B.	56	64	59	49
	G.	12	17	18	22

Biography, history, poetry, science, travel, information, and humor had small percentages in each case.

From this table and from similar tables for magazines and for both books and magazines the following results of the investigation were obtained:

Boys are greatly interested in books and magazines of adventure. Indeed, they choose these magazines more often than any others. Nearly 60 per cent of the total choices fall in this group among the books. Such books as *The Call of the Wild*, *Treasure Island*, the Boy Scout Series, and more recently those of Zane Grey, and such magazines as the *American Boy* and *Boys' Life* are always among the leaders in interest from years 12–18. Then, too, about 50 per cent of the total votes are cast in favor of magazines of adventure. They also like, probably for the same reason, *Huckleberry Finn* and *Tom Sawyer* among the books, and *Popular Mechanics* and *Popular Science* among magazines. Second only to this enormous interest in adventure is that in fiction. Among the younger boys this urge finds expression in juvenile fiction much of which has an adventurous turn. They enjoy Altsheler's *Guns of Bull Run* and *Texan Triumph;* Barbour's *Left Tackle Thayer;* and Henty's *By Pike and Dyke.* As boys get older they turn more and more to adult fiction until at 17–18 years this type includes 30 per cent of the total votes. Magazines, too, reflect this interest. From 20–25 per cent of the votes for the most popular magazines were classified in this type. In the more recent investigation of 1925 *The American Magazine* proved to be the most popular magazine of all except at the ages 12–13.

Girls like fiction best of all. Among the books which lead the lists are: *Girl of the Limberlost*, *Anne of Green Gables*, *Seventeen*, Zane Grey's books, *Pollyanna*, *Freckles*, and *Laddie*. All told, from 70–80 per cent of the votes for most popular books were cast for fiction. The leading magazines reinforce the contention that fiction appeals to the average girls. *The American Magazine*, *Ladies Home Journal*, *Cosmopolitan*, *Good Housekeeping*, and *Pictorial Review* top the lists. Two-thirds of the girls in listing the three magazines they like best of all include *The American Magazine*. Girls also like books and magazines of adventure though to a much less extent than they do fiction. From 12–22 per cent of the choices of books fell on adventure. *Tom Sawyer*, *Treasure Island*, and the *Tale of Two Cities* not infrequently were listed and now and then a girl may be found who prefers this type of reading above all others. Among magazines of adventure their interest is very small.

Boys and girls are alike in reading little poetry. In the libraries there could be found behind the poetry, books of great interest to boys and girls who somehow had learned that here was a place which would not be disturbed and consequently they "bunked" their favorites here. History, science, information, and humor fare little better than poetry in the votes of high school and upper grade boys and girls. When we turn to magazines a somewhat different story appears. Boys like very much magazines of a scientific nature (16 per cent); girls do not (2 per cent).

Boys and girls both like those dealing with current events (5–10 per cent).

It thus seems clear that boys and girls are very much interested in reading of a certain kind. The author on several occasions has observed children in a line a half block long waiting for books of fiction. He has observed their exclamations of disappointment when they did not obtain the books they wanted. He has been asked by boys who took him as an inspector to order "100 Altshelers and 50 Hentys." The school's job is to find which books are interesting *and* wholesome and to make them available to children. Much practice in reading may be had as a by-product of this urge as well as a development of a genuine liking for books. Moreover, it seems reasonable to suppose that rapid silent reading of easy material may tend to increase the size of the unit of recognition in reading, of which we shall speak later.

The Project. Purposive activity is an excellent illustration of mental set and it is at the very heart of the project. A project in the modern sense of the word may be illustrated by the building of an aërial tower for a radio set. Two boys, 12–13 years of age, became very much engrossed with radio and so they planned a tower taller than any other in a city of 8,000. They were boys with small financial backing so that they had to work at odd jobs to make the necessary money. After much discussion concerning the best type of material for the money they had, small wooden lathes five or six feet long were chosen. They worked on their tower from day to day until it was finally finished. This illustration (an actual one) embodies the essence of purpose, of planning, of executing and of judging (Kilpatrick). You will notice that this was no problem given to them by some outsider but one originating within their own minds. It is not necessarily true that the project must be planned by the one who executes it but it does mean that the executor must whole-heartedly accept the plan as his plan and when finished the results must be thought of as his results.

Let us examine the project in the light of our laws of learning. Purposive activity makes certain neurones ready to conduct. It sends ahead stimuli which close certain pathways and make others more ready to act. Consequently the satisfaction arising will be dependent upon the mental set. "The purpose acting as aim guides the boy's thinking, directs his examination of plan and material, elicits from within appropriate suggestions, and tests these several suggestions by their pertinency to the end in view. . . . The purpose thus supplies the motive power, makes available inner resources, guides the process to its preconceived end, and by this satisfying success fixes in the boy's mind and character the successful steps as part and parcel of one whole." (Kilpatrick, *The Project Method*, p. 9.) From the educational point of view the most important thing is this drive which the project furnishes, this incentive which grows out of the situation. Most important of all is it that projects arouse the need for knowledge which is usable in carrying the project to a successful completion. Now let us look at that aërial tower again. The completion of this thing brings a certain joyous satisfaction which causes the processes connected therewith to be repeated and consequently learned more precisely and accurately. Furthermore, such satisfaction may carry over into ideas connected with the radio, such as the physics involved, so that from the study of such a project there may be had an abiding interest in the radio and in the principles which make possible the conduction and recording of electrical waves through the atmosphere. It is these phases of the project which give us pause and make us wonder if it is not worthwhile, despite the time it takes and the energy it expends.

Incentives are dynamic drives influencing human action in a variety of ways. Thus far there has been experimental exploration of them in only a few cases, but whenever such procedures have been carefully carried out the results have been clear-cut and decisive. Knowledge of results effects an improvement of 38 per cent; money rewards, a much higher percentage of gain; praise, something over 80 per cent; and reproof, about 20 per cent. Rivalry, too, exerts a measurable influence on learning. But, after all, the most important incentive arises out of a condition when the pupil is thoroughly aware of the significance of the material learned to him, material that somehow connects up with his life in such a way as to appear to him as being worth while and valuable, that, in a word, is interesting to him.

III. *Educational Conditions of Improvement.* The strictly educational conditions differ from the physiological and psychological conditions in pertaining more particularly to the selection and arrangement of the material to be presented. The physiological conditions would undoubtedly affect the process of learning by which material is assimilated by making more or less ready the neural pathways; the psychological factors would also have an influence due to the directive force of interest as well as the intensity of the reaction; but the educational conditions concern the situations themselves, the choosing of them and their arrangement. There is some overlapping between the psychological conditions and the educational since the interest of the former is determined by the significance of the material to the pupil and this last is dependent upon the sort of material chosen to be presented. Real honest-to-goodness interest, too, almost always arises out of the arrangement of the subject matter in the execution of some felt purpose so that all of these three are frequently intertwined but may be separated for purposes of study.

Educational conditions of improvement, then, are immediately concerned with the selection of subject matter which shall enter the curriculum and with the arrangement of the material so as to produce the most efficient learning. Efficient learning here is to be defined as equivalent to that by means of which the learner gains *full meaning* of the material studied in the quickest possible manner. What materials shall be chosen? A question most easily asked but most difficult to answer. In certain cases, say spelling, the bonds to be formed are becoming better and better agreed upon. The thousand most frequently used words are now at hand (Ayres spelling scale), indeed the 10,000 most frequently used words have recently been made available (Thorndike, *Teachers' Word Book*) so that any teacher can teach as many of these commonly used words as the time allows. Of course, other criteria might be used in selecting words, but this one seems fairly satisfactory. Once these words are ready for use, what order of presentation shall we employ? Shall each word be presented on the board, have its meaning explained, be pronounced aloud, and then be written by the pupil? Is it a better way for the children to be given all the words and then have them specialize on the words which are missed? This has been made an individual matter by dividing the children into pairs. Each member of the pair calls out the missed words to the other member and vice versa. The teacher then checks up the work by having the child spell these words correctly four or five times before they are left. Or, indeed, shall the list of misspelled words be selected from the words that the pupil spells incorrectly in his own compositions? And reading, what of it?

Reading offers an excellent illustration both of the selection of bonds and of their arrangement. In the first place, what bonds shall be formed? In the last few years the agreement has become more and more unanimous that (1) the most important habits to be formed are the ability to read silently and comprehendingly the ordinary material contained in newspapers, weekly and monthly magazines, and ordinary literature, and (2) the ability to do this reading quickly. The change of aim from oral to silent reading, from calling words to getting thought, has influenced the selection of subject matter all the way through the elementary school. It is now understood that in beginning the study of reading with the study of letters and in building these up into syllables and these in turn into words, we may defeat the desired end for the reader may get stranded on a word- or syllable-reading stage instead of slipping easily past that into the phrase-reading and comprehending stage.

Finally, the selection of material in geography and history illustrates nicely this point. Instead of beginning with the earth as a whole, then proceeding to the continents, and thence in turn to the countries, to the states, and finally to the counties, the order may be changed rather radically. Geography now begins with a study of local conditions. Local and county maps may precede those of the whole country. Thus the idea of meaning and significance permeates the selection of material. In history much emphasis has recently been placed on the study of the development of peaceful industries, on visiting places of historic interest, and on beginning with local history.

It is seen from these illustrations that the educational conditions of selection and arrangement of material are of surpassing importance in getting the full coöperation of the learner in our task of education.

The determination of the strength of the bond is another important educational condition. Just how well should we expect children to know United States history? How many examples in addition in eight or ten minutes can we expect? How well may we hope that children can spell ordinary words? In the first place, there are well-established norms of attainment in most of the elementary subjects. These norms are nothing more than the average performance of the pupils of that grade or of that age upon some standard test. Thus there are norms in spelling, arithmetic, reading, and handwriting. In the second place several students of tests have urged a sort of ideal standard for pupils in a certain subject for a certain grade. Thus Courtis regards twelve examples, each of nine three-place numbers, as the proper number to be added accurately in eight minutes by the child who is just finishing the eighth grade. By "accurately" he means 100 per cent accuracy—a goal which but few can attain. In the same subject Thorndike has said that if a pupil could add a seen one-place number to a thought of two-place number in three seconds with an accuracy of 199 out of 200, and check the work by adding twice, he (the pupil) would have little chance of being incorrect. In this manner he suggests the amount of accuracy to be desired. Trabue places a scale value of 5.5 on the Hillegas composition scale as a desirable average for eighth grade pupils in English composition.

Individual differences within the school subject might be considered as falling under educational conditions. The results of our instruction upon original nature are of such a differential nature that very wide abilities are found in the ordinary class.

Table V shows such a class. This class is about average in that at the end of the year they were up to the fifth grade standard of the country. It will be noted that the reading ability of this class varied all the way from below third grade ability to a considerable amount above the sixth. It is a problem of the first magnitude to provide for the individual differences exhibited here since there are such diverse abilities in reading. The type of reading which would stimulate a pupil who can earn 51 on this test is utterly beyond him who earns 32 and vice versa. If we provide for the latter, we bore the former. It is this provision for individual differences which we shall discuss in a later chapter.

TABLE V

Showing the Variations within One Grade as Measured on the Thorndike-McCall Reading Test

Grade V in December

Grade		*f*
	54	1
	53	
	52	1
VI	51	
	50	2
	49	
	48	
	47	2
V	46	
	45	1
	44	6
	43	1
	42	
	41	8
IV	40	5
	39	2
	38	
	37	3
	36	2
	35	
	34	1
III	33	2
	32	
	31	1
	N	38

Summary

There are three general conditions of learning: the physiological, the psychological, and the educational. These three overlap in many respects but may be separated for purposes of more complete analysis.

Under physiological conditions we include all those difficulties of a less serious nature which affect the learning process. Diphtheria, typhoid fever, etc., are not included because the learning process stops entirely. We include here only those minor diseases which prevent the child from living at 100 per cent efficiency. Moreover, the effects of alcohol, opium, strychnine, etc., are fascinating studies but are not significant problems of childhood. Uncorrected defects of eyes and ears are found to exist entirely too often and methods of testing these organs are suggested. These defects prevent the child from forming a clear perception of the material to be learned. Adenoids and tonsils affect the general attitudes and outlooks of children and may be influential in producing a dislike of school subjects. Consequently, their removal produces better school work but has little measurable effect upon the more fundamental traits tested on the Binet Scales. Changes of temperature seem to have very little effect upon either the desire to learn or upon the amount learned. The experiments proved inconclusive because they were not extended over a long enough period of time and the conditions were not severe enough to produce the more disastrous results. Well-controlled experiments on the effect of hot lunches upon efficiency in learning would be very interesting but there are none available.

The psychological conditions are chiefly concerned with mental set or attitude and interest. Set or attitude determines what connections will be satisfying and which annoying, which will be repeated and which not. In Book's study the mental set aroused by displaying the records of previous experiments produced a measurable result on the speed of learning. In Hurlock's study the praised group surpassed the reproved group in improvement made after the first day. Thus the correct mental set produces measurable increases in rate of learning. Interest, too, has an effect but one thus far less open to measurement. It has a leading-on aspect which affects pupils in such a way that they will want to continue their work or some work similar to it after the class is over. It is seen that the urge to read books of a certain type was based on interest. One way to stimulate further reading was to select a large number of interesting books for the local library and to keep in the classroom itself well chosen parallel readings.

The educational conditions overlap the other two in several respects and looked at in some ways might include all others. But here we have included the selection and arrangement of material as well as the thoroughness of its learning. Most important of these, perhaps, is the selection of the proper material to be included in the curriculum. Material is selected for its high social value rather than for its disciplinary value. It should to as great an extent as possible grow out of the life experiences of the learner. The arrangement of the bonds depends upon the purpose of the course. Since the aim of teaching reading is to read quickly, silently, and understandingly ordinary material, the plan from the first is to make provision for emphasizing this purpose. Ordinarily it is not good policy to begin two bonds at once nor to form any bond which will later have to be broken. The strength of bonds needed to be formed in school is being rapidly determined and in some subjects adequate goals have been agreed upon. In general, we make every provision for the careful learning of the most important material by means of drill lessons and carefully timed reviews.

QUESTIONS AND EXERCISES

1. Outline the chapter. Use about one-half page to indicate the leading points. Organize the facts under three heads.
2. Just what is meant by physiological conditions?
3. Perform the following experiment:

Apparatus. Lowell Chart.

Procedure. Place chart at about the same level as the subject's eyes. Seat subject twenty feet from chart. Instruct subject to keep both eyes open. By means of a card cut off the vision of the left eye. Keep the chart in a strong even illumination. Have the subject read the lines above the red strip. If this line can be read entirely or if all the letters can be read save one, proceed to the lines beneath until he fails to name correctly two letters in one line. If he cannot read those above the red strip proceed upward to the line in which he can read all the letters. Record on your notebook the number to the left of the smallest line that the subject can read (thus, if he reads the line just above the red strip we record 1 for that eye, or V. R. E. 1, i. e., vision, right eye is 1). Now have the subject cut off the vision of the right eye with the card and proceed with the left eye as above.

In carrying out this experiment ask the subject if he has suffered with headaches, pain in the eyes, if he has ever worn glasses. Look for inflammation of the eyelids, watering eyes, or any other indication of soreness. If he wears glasses test him with glasses *on.* (See Whipple's, *Manual of Mental and Physical Texts,* Part I, pp. 166ff.)

4. Watch test for auditory acuity.

Apparatus and Conditions. Ordinary watch, a large quiet room.

Procedure. Plan out a place for the subject to sit at least five feet from the nearest wall and in such a position that the experimenter may walk out as much as five or six feet in each direction from the subject's ears. Mark out on the floor a chalk line which runs in the direction in which you advance while examining the hearing (this line is in a direction perpendicular to the median plane of the body, or directly out from the ear). At spaces of one foot make crosslines so that we have a line marked at intervals of one foot running out directly from underneath the ear in the direction from which the sound comes when the ear is best adjusted to it. There will be one of these marked-off lines for each ear.

Seat the subject in a comfortable chair. Provide some rubber stoppers to plug up the ear which is not being tested. Hold the watch always in the same hand and in the same position in the hand. Have subject close his eyes. Then beginning quite near the tested ear move outward along the chalk line and at each of the crosslines simply say "now" which is a brief way of asking after it has been explained to the subject, "Do you hear the watch *now?*" The subject merely answers "yes" or "no." At times the subject may think he hears the watch when he actually does not. To guard against this error test the subject at the ordinary distance with the watch tightly covered between the two hands. If the subject seems to hear the watch at five or six feet under these conditions he is most probably imagining. In which cases the experimenter says "No. I want you to say you hear only when you actually do." It is well for each student to get the records from each of the other students in the class and make an average and then calculate how much each member of the class deviates from the average. If all the members of the class use a laboratory watch the results will be more comparable. The individual has defective hearing if he cannot hear an ordinary watch at a *distance of three feet.* The better procedure is to take the average distance from the ear of a given person; the watch is heard as the numerator and the average distance for the class as the denominator. If a person's fraction is less than .85 in either ear or if he suffers earaches or discharging from the ear he should have an examination by an expert at once.

5. Why are not the effects of alcohol included?
6. Distinguish between physiological and psychological conditions of learning.
7. Explain physiologically the conditions of interest.
8. What is meant by "set"? Is it mental or physiological? Why?
9. When might reproof produce a mental set, when approval, when rivalry?

10. Cite three ways not mentioned in the text in which rivalry may legitimately be used to motivate school work.
11. What did James mean by saying "Nine-tenths of the work of the world is done by it (rivalry)?"
12. What are the advantages in being a rival with your own past record?
13. To what instincts are these urges related?
14. Cite the precise advantages of knowledge of results in learning.
15. What is the difference between the effect of praise and reproof?
16. Why do we say that the just mentioned incentives are from the outside?
17. Does the project illustrate mental set? How?
18. Name and explain the four phases of a project.
19. Plan out a project in the subject which you intend to teach. Can you be sure that this would be a project for the pupil? Why?
20. Distinguish between the educational and psychological conditions of improvement. Why is this such a difficult problem?
21. How might it truthfully be said that all these conditions are educational?
22. How can standard tests be used to set attainable goals in learning?
23. What is the difference between the norms of the standard tests and the desirable goals described by Courtis, Thorndike, and Trabue?
24. Explain how the aim of a course determines its method.

REFERENCES

Arps, George F. "Work with Knowledge of Results *vs.* Work without Knowledge of Results," *Psychological Monographs*, 1920, Vol. XXVIII, No. 3.

Book, W. F., and Norvell, Lee. "The Will to Learn," *Pedagogical Seminary*, 1922, Vol. XXIX, pp. 305–362.

Chapman, J. Crosby, and Feder, R. B. "Effect of External Incentives on Improvement," *Journal Educational Psychology*, 1917, Vol. VIII, pp. 469–474.

Gates, G. S., and Rissland, L. Q. "Effect of Encouragement and of Discouragement upon Performance," *Journal Educational Psychology*, 1923, Vol. XIV, pp. 21–27.

Gilchrist, Edward P. "The Extent to which Praise and Reproof Affect a Pupil's Work," *School and Society*, 1916, Vol. IV, pp. 872–874.

Hurlock, Elizabeth B. *The Value of Praise and Reproof as Incentives for Children*, 1924.

Hurlock, Elizabeth, B. "An Evaluation of Certain Incentives Used in School Work," *Journal of Educational Psychology*, 1925, Vol. *16*, pp. 145–159.

Kilpatrick, W. H. *The Project Method*, 1919.

Kirby, Thos. J. *The Results of Practice under School Conditions*, 1913.

Kitson, H. D. "A Study of the Output of Workers under a Particular Wage Stimulus," *Universal Journal of Business*, November, 1922.

Knight, F. B., and Remmers, H. H. "Fluctuations in Mental Production when Motivation is the Main Variable," *Journal of Applied Psychology*, 1923, Vol. VII, pp. 209–224.

MacPhail, A. H. "Adenoids and Tonsils. A Study Showing How the Removal of Enlarged or Diseased Tonsils and Adenoids Affects a Child's Work in School," *Pedagogical Seminary*, 1920, Vol. *27*, pp. 188–194.

Rogers, Margaret Cobb. *Adenoids and Diseased Tonsils. Their Effect on General Intelligence*, 1922.

Ross, C. C. An Experiment in Motivation," *Journal of Educational Psychology*, 1927, Vol. *18*, pp. 337–346.

Smillie, W. G., and Spencer, Cassie R. "Mental Retardation in School Children Infested with Hookworm," *Journal of Educational Psychology*, 1926, Vol. *17*, pp. 314–321.

Strong, E. K. "Effects of Hookworm Disease on the Mental and Physical Development of Children," *Bulletin No. 3, Rockefeller Foundation.*

Terman, L. M. *The Hygiene of the School Child*, 1914.

Thorndike, E. L. *The Psychology of Arithmetic*, 1922.

Thorndike, E. L. *The Psychology of Algebra*, 1923.
Thorndike, E. L. *Educational Psychology*, Vols. I and III, 1914.
Thorndike, E. L., McCall, W. A., and Chapman, J. C. *Ventilation in Relation to Mental Work*, 1916.
Wallin, J. E. W. *Mental Health of the School Child*, 1914.
Washburne, Carleton, and Vogel, Mabel. *The Winnetka Graded Book List*, 1925.
Whipple, G. M. *Manual of Mental and Physical Tests*, Vol. I, 1914.

CHAPTER V

THE LAWS OF LEARNING ILLUSTRATED BY REFERENCE TO ELEMENTARY SCHOOL SUBJECTS

The laws of learning developed in Chapter III help us to interpret the learning of elementary school subjects. Reference will be made here to:

1. Handwriting
2. Reading
3. Arithmetic
4. Spelling
5. History
6. Appreciation of Poetry.

1. Handwriting

Handwriting falls into that category known as sensorimotor learning. By sensorimotor learning we mean a situation-connection-response series in which the response is outwardly muscular, i. e., an overt response. The principles of learning apply unusually well to all the conditions found here. The set or adjustment towards the desired response is not difficult to attain since the response is so evident. Furthermore, for the same reason it is easy to attach some satisfaction or discomfort to it, as the case may be, thus selecting the desired response, and eliminating the undesirable one. In spite of these difficulties all animals may finally hit upon the solution provided the problems are within their reach. But the fixation and integration of the habits may progress rather slowly because of the difficulty of controlling the response. The cat finally hits upon the button as the important object, the chimpanzee puts the two sticks together, the human being finally unlocks the door. In each case the movement is usually accompanied by a feeling of satisfaction or annoyance and whenever this response is a simple one this feeling readily attaches to the correct response. It is found that the greatest improvement in motor learning takes place when the S is clearly understood and the correct R is certainly distinguished from the other possible ones. Great efforts are made in educational practice to bring about this clarity of understanding.

a. *Set of Adjustment.* One of the most important first steps in learning handwriting as in learning every other school subject is the establishment of a desire to improve, or of the right mental set towards this subject. This is not difficult to do because of the universal use of handwriting. Furthermore, the results of the child's efforts are immediately apparent to him and the attachment of satisfaction to the desirable bond and of annoyance to the undesirable ones is a comparatively easy matter. On the other hand, the desirable movements are very difficult to control.

b. and c. *Selection and Elimination.* The child comes to his lesson in handwriting with a large number of movements available. The problem is to assist him to select the movements appropriate for handwriting. In accomplishing this task some teachers have tried using tissue paper over writing and have the child trace the letters directly; others have had the child trace in a groove the desired letter; while others still have simply guided the movement of the child's hand in the early stages of this habit. In spite of the fact that these methods have proved to be rather ineffective, all of them have aimed to give to the child the feel of the correct formation of the letter so that he could select the best method of forming it.

In improving handwriting, it is sometimes helpful to assist the learner in the understanding of the various features involved in the process, e. g., spacing, alignment, letter formation, etc. Freeman's chart for handwriting, a section of which is given below, aids the teacher in recognizing the various errors which the pupil is likely to make in improving his writing, for the teacher has before him samples of good and poor quality in alignment, letter formation, spacing, etc., and can analyze the errors which the pupil makes. This makes it possible to have the pupil practice just that phase of handwriting which he performs least successfully. Just as in many other sorts of motor learning general practice helps very little to improve the function but specific practice at just the right point is of great help.

What suggestions can experimental knowledge offer by way of simplifying the learning process in handwriting so that the proper bonds may be selected more easily? One experimenter (Freeman) has carefully analyzed the movements of good and poor writers. Some of them were in the fourth grade, some in the fifth, and the rest were distributed throughout the upper grades, although there were some representatives from the adult level. The children of this investigation came from two separate schools one of which used carefully worked out practice and drill lessons while the other permitted more freedom of position and movement. Careful analysis was made of the form, speed, and general process of handwriting by means of photographing the movements of the hand with a moving picture camera. From this careful analysis of the movements in handwriting certain inferences which bear directly upon its learning seem clear.

d. *Fixation of Habits. The Principles Derived from Freeman's Experimental Work Bear Directly on the Learning of Handwriting.* One of the greatest difficulties arising in connection with the formation of this habit is that of moving the hand easily along the page so that there is freedom of movement at all times. To accomplish this the pen must be held rather loosely. It is better for the forefinger to be nearer the point of the pen than the thumb and the hand must slide along the page without difficulty either on the nails of the third and fourth fingers, or on the knuckles, or even on the side of the hand. The essential element of the process seems to be the ease of movement. Moreover, this very freedom is facilitated if the hand is held at about 90 degrees with the line of the paper and if the arm rests comfortably on the muscle pad of the forearm. For most individuals it is better to hold the paper at an angle of about 30 degrees with the edge of the desk. This slight slant of the paper makes it easier to hold the hand at right angles with the lower edge. It seems useless to attempt to prevent finger movements since even the most expert writers use finger movements to a slight extent. In making the curve to the left the middle finger pushes harder on the pen, while in a movement to the right the thumb exerts the greatest amount of pressure. To obtain the best results, it seems advisable to aid the child in separating the writing into desirable units. Counting while writing, in the earlier stages of the formation of the habit, seems a useful method for separating the units.

e. *Integration.* As previously mentioned, it is of surpassing importance to obtain smooth-running, consistent habits. It is easy to attach satisfaction to some of the more easily distinguishable elements such as holding the pen, position of the body, and to attach annoyance to improper position of the fingers and arms. Success in these instances comes early, for repetition with intensity is easy to obtain and so the habits are fixated. But the more subtle bonds connected with the proper speed of the formation of the different parts of the letters, the grouping of letters, the smooth easy movement from left to right are more difficult to distinguish and it is harder to know precisely just when they are correctly formed. Speeding up the tempo of the writing habit by having children write to the beat of a metronome or to the counting of the teacher is one means of gaining this end. Furthermore, by analyzing the pupil's handwriting it is possible to discover precisely what phase of the habit is holding the pupil back on a low habit level. Such a chart as that of Freeman (Figure 12) is helpful here. By means of getting intensive repetitions of these troublesome points the desired coördination of the simple habits into a larger unitary habit may be secured.

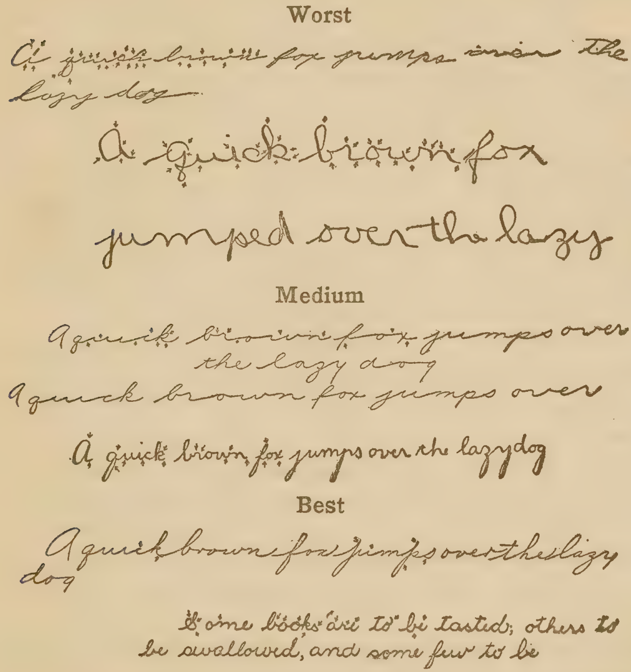
Worst
Medium
Best

FIG. 12.—Excerpt from Freeman's Diagnostic Chart in Handwriting which illustrates the analyses of letter formation.[1]

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[1] Freeman, Frank N. Chart for Diagnosing Faults in Handwriting. Houghton Mifflin Company.

2. READING

Because of the great amount of experimental work which has been done in reading this subject offers a rich field of illustrations.

a. *Set or Attitude.* In beginning reading much attention is now given in the first grade to the securing of the correct mental set. Care is taken to make sure that the pupils, particularly at first, begin their reading with material of great interest to them. Stories that children like, action words, their own names, are some of the materials used. More specific sets are stimulated towards the naming of the word or the correct selection of a word which is the name of the object in the picture. As children acquire more mastery of the subject, the getting of the proper set determines to a very large extent the meaning of the material read.

Set or attitude may be illustrated by the pronunciation which is given to two words spelled just alike but occurring in different contexts. Thus the word "tear" would be pronounced quite differently if the paragraph had been dealing with the escape of an individual from a raided prize fight from what it would have been had there been discussion of sorrowful experiences. The paragraph creates the attitude which determines the way a word of two meanings is to be produced. The following quotation from Thorndike illustrates the disaster which befalls a reader when the wrong mental set is taken. A paragraph with the appended questions was given to 600 pupils in Grade VI.

> Read this and then write the answers to 1, 2, 3, 4, 5, 6, and 7.
>
> Read it again as often as you need to.
>
> In Franklin, attendance upon school is required of every child between the ages of seven and fourteen on every day when school is in session, unless the child is so ill as to be unable to go to school, or some person in

his house is ill with a contagious disease, or the roads are impassable.

1. What is the general topic of the paragraph?
2. On what day would a ten-year-old girl not be expected to attend school?

Five other questions were asked about this paragraph.

Samples of answers to question 1, showing the wrong mental set:

Franklin
Franklin attendance
Franklin School
Pupils in Franklin
How old a child should be
If the child is sick or contagious disease
The roads are impassable.

Samples of answers to question 2:

On her birthday
On her fourteenth birthday
On every day
On Monday
On Friday
On Monday and for five days a week.

It thus seems clear that any word may be detached from its original surroundings and attached to the complex of experiences within the mind of the child.

The significance of interest in reading as a psychological condition of improvement was treated in Chapter IV. Interest is also important in getting a large amount of reading done, so that the connections formed may be exercised. By having a library of interesting books near at hand, pupils form habits of turning to books for purposes of recreation, and thus form the right attitude towards them.

b. and c. *Selection and Elimination.* The satisfaction that the child gets when learning to read in carrying out, for example, what the word suggests, or in placing the correct name on his comrade, or in finding his own name, in discovering words which advance the story, helps to select the correct perception of the word being studied and annoyance at the perception of the wrong word tends to eliminate the incorrect perception. Thus to call the word b-e-a-r, "boy" obtains for him the annoyance produced by the quick correction of his comrades, but to call it "bear" brings for him the commendation of all and consequent satisfaction.

d. *Fixation.* The fixation of reading habits may be rather cleverly done by the simple device of both repetition and intensity at one and the same time. This is secured by a judicious selection of a great deal of interesting reading material at about the same level of difficulty. In this way many words must be recognized at least a hundred times and each time in a slightly different connection. Probably in no other subject is this combination of intensity and practice so successfully accomplished as in reading. As a consequence of the industry of many workers in the selection of large numbers of interesting stories the normal child acquires his reading habits quickly and efficiently with a maximum of interest.

e. *Integration and Organization.* The process of integration and organization of reading habits has best been attacked through photographs of eye movements. Once it had been demonstrated that eye movements were closely correlated with the actual process of getting the meaning from the written page, it was possible to analyze habits of reading in terms of eye movements and thus to get an objective record of silent reading. It was found that the smaller number of eye fixations on a page were accompanied by a greater comprehension in reading, that periods of confusion of the eye were accompanied by hesitation in the voice, and that new and difficult words introduced into easy reading produced a new type of eye reaction. It has thus become possible to describe reading habits in terms of eye movements. For example, one student (Buswell) contrasts a first grade reader and a college senior as follows:

	First Grade	*College Senior*
Words read per minute	39.6	369.
Number of fixation pauses per line	21.3	3.6
Number of backward or refixating movements per line	6.8	0.0
Time for fixation	.45 secs.	.32 secs.

It is thus seen that the skilled reader reads the same material almost ten times as fast as the beginner, makes about one-seventh as many pauses, has infinitely fewer periods of confusion, and uses about seven-tenths as long a time per fixation pause. The tracing through of these processes from their beginning to their perfection is eminently worth our consideration.

Reading Habits. Taking our cue from the study of eye movements we may trace through the development of three habits. These are:

a. The number of fixation pauses per line.
b. The length of the fixation pauses.
c. The number of periods of confusion or refixation.

The number of fixation pauses is directly related to the quality of reading. It is an indication of the size of the unit of recognition. Little children, just beginning their reading, never comprehend more than one word and sometimes not that much during one moment of fixation. As the children grow older they include more and more units in one fixation until the adult averages almost two words.

Figure 13 shows that during the first four grades there is a rapid decrease in the number of fixation pauses, but after these there is very little change from year to year. On investigation (Buswell) has found the average number of fixations of the eye in the first grade to be about 15 or 16; in the third grade about 9; in the fifth grade about 7 with very little change thereafter until the sophomore year in high school where the average is about six fixations per line. In the fifth grade less than one-half as many fixation pauses are made as in the first grade. Thus there are more than twice as many words comprehended in one fixation pause. The inferences from such data make even more imperative the proper methods of instruction during the first four grades. If the proper habits are not formed then, they are formed later only with the greatest difficulty.

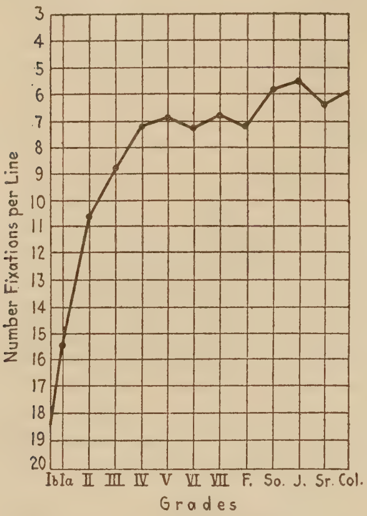

FIG. 13.—Growth stages for average number of fixations per line in silent reading. School grade shown on horizontal axis; average number of fixations per 3.5 inch line shown on vertical axis. (Buswell, G. T., *Fundamental Reading Habits*, p. 27.)

Concomitantly with the decrease in number of fixation pauses per line appears also a decrease in time for each fixation. One might think that the contrary would be true, that as the size of the unit of recognition increased it would take a longer time per fixation. Not so, for in smooth-running reading both large units and quickness of perception appear. The decrease in time is from about .5 or .6 of a second in grade I, to .2 or .3 in grade IV, to .2 in grades VI and VII after which time there is not much change.

As far as the speed of recognition is concerned, by the time the average child has reached the fifth grade there is no further improvement.

Regressive movements disappear rapidly as we progress from the first to the fifth grade. Beginning with an average of 5.1 refixations per line in I B, the number has decreased to an average of 1.3 in the fifth grade and to .7 in the senior class in high school.

In reading we have an excellent illustration of the organization and integration of habits. From the ability to comprehend a word haltingly, in a considerable period of time, intensive repetitions have changed the process to such an extent that large units are easily recognized, easily and quickly read, with no period of hesitation or confusion. Many simple habits coöperate in the activity of getting quickly the meaning from the written page. Consider the amount of short-circuiting in the S→R Connections, the process of fusion of stimuli, the rapidity of response when the stimulus is given; when an individual who in the first grade reads 39 words per minute and as a senior in college reads 369, whose eyes at that time paused 21 times per line and now less than four; whose eyes then made nearly seven regressive movements and now make none. Reading thus furnishes a capital illustration of the organization and integration of habits.

3. Arithmetic

a. *Set or Attitude.* One might distinguish two varieties of sets; one of them a general adjustment towards arithmetic as such; the other the specific adjustment towards the problem at hand. The desirable general attitude is developed in two ways, (a) by selecting material from life's situations and by then pointing out to the pupil this fact; and (b) by choosing problems and exercises which grow directly out of the child's experience. An illustration of the former procedure appears in the teaching of fractions. When a child begins to have difficulty with learning fractions, one might point out to him that 95 per cent of the fractions used in ordinary arithmetic computation occur among the following: $^1/_2$, $^1/_4$, $^3/_4$, $^1/_3$, $^2/_3$, $^1/_8$, $^3/_8$, $^1/_5$, $^2/_5$, and $^4/_5$ (Wilson, G. M.) and since these are used so widely he is learning facts of great importance. The second point is illustrated by the type of problem to be chosen out of the child's ordinary experience. Here is a problem which a young child 8 years old had actually confronting him. He had $1.25 to spend on his vacation. One morning he spent 20 cents on a merry-go-round; 15 cents on a scenic railway; and 30 cents on throwing balls at a target. The question then arose as to how much he then had left to spend.

The second type of set is illustrated in the attempted solution of various simple arithmetic problems in grades three and four. Quite frequently the pupil has much difficulty in deciding whether he should add, subtract, multiply, or divide. One of the ways recently found helpful is to give pupils much practice in estimating the answers. By this means the correct set may be so taught that the pupil may come to distinguish sharply between the different processes to be used. With little children signs like "+," "—," and "×" have been used to obtain the correct set, although these crutches cannot be depended upon to any great extent, since connections are being formed which have to be broken later.

b. and c. *Selection and Elimination.* Selection and elimination are both illustrated in the way children learn the meaning of numbers. Ordinary figures which seem to us so simple are far from simple to the child. He must proceed slowly and laboriously to learn their significance. This process of counting begins with an inner rhythmical beat. Soon the child begins to use the numerals 1, 2, 3, 4, etc., merely as in the positions where rhythmical beats would occur. Gradually, by means of selection of satisfying responses and elimination of annoying ones, this process becomes sufficiently mechanical for him to bring to an exact correspondence the external objects and the counts so that a one to one relation is established. After this he may proceed to count numbers in groups and to perceive collections and finally, the rational use of numbers is acquired. Some sort of voluntary movement seems necessary in any sort of accurate counting. Eyes are turned towards the object, fingers are pointed, the objects are counted on the fingers. It may even be impossible to count correctly without some type of voluntary movements. This is ample explanation for children's use of fingers, strokes, pointing, etc., in keeping a careful record while counting. Normal children can ordinarily count to twelve or thirteen by the time they arrive at school. They have established that one to one relation between figures and objects and have learned to make simple abstractions which enable them to lump objects, somewhat unlike, together into one category. For example, they are able to count the chalk, flowers, etc., as objects on the table, thus showing their capacity to perceive the number relations separate from the differences in shape, size, or purposes for which used. In brief, the learning of arithmetic furnishes examples beyond number of the selection and elimination of bonds in accordance with a mental set and determined by satisfaction and annoyance.

d. *Fixation.* The processes of repetition and intensity to gain fixation of arithmetical habits have been studied so thoroughly that children no longer need to be weak in the fundamentals of arithmetic. *First,* a thorough analysis has been made of the thousands of errors made by children and the difficult bonds and easy bonds are now known, "difficult" being defined as those in which children make many errors, while "easy" are those where children make few errors. For example, let us take the study of errors in addition and subtraction.

Study of Errors in Addition and Subtraction

Some addition combinations, it has been found by a study of the errors made, are much more difficult to learn than others. The combinations 8+5
7+9
5+8
9+7
6+8
seem much more difficult than 0+0
5+5
2+2
2+1
1+7 (Clapp). When errors are counted the first five combinations give the largest number of errors; the last five, the fewest. This process of error analysis gives us, in addition, knowledge of the degree of strength attained by the habits. The following table was developed from a detailed analysis of errors made by pupils in the Cleveland Survey tests in arithmetic:

TABLE VI

Types of Errors in Subtraction (Arthur S. Gist)
(Judd and Buswell, 1925)

Grade	*IV*	*V*	*VI*	*VII*	*VIII*
Subtraction					
Borrowing	54	56	52	51	55
Combinations	36	38	45	44	41
Omissions	2	1	2	3	1
Reversions	1	2	.5		
7–0, 0, etc.	5	3	.5		
Left-hand digit					2

It is thus clear that borrowing and combinations are responsible for by far the greatest number of errors. Osburn in an analysis of 21,000 errors of pupils in arithmetic found that, in subtraction, 40 per cent of the errors were due to bridging and 20 per cent to zero difficulties. Another investigator (Scott) reports that in an elementary class 34 per cent of the errors in the fundamental arithmetical operations were due to mistakes in carrying. Some of the most difficult subtraction combinations to form are 14–9; 13–4; 16–9; 14–5; 17–9: while 0–0; 5–1; 7–7; 3–2, and 3–3 are among the easiest to form.

Once the errors have been localized it is not difficult to arrange the situations so that intense repetition may be had and progress in fixation made. This effect of intense repetition is illustrated by the following investigation (Brown). This piece of research divided 51 children from grades VI–VIII into two equivalent groups. One of these, the experimental group, received at the beginning of the recitation each morning five minutes of intense drill; the other group, the control, was taught in the ordinary way. This procedure lasted for thirty recitations. The Stone Arithmetic tests were given before and after the drill period. (Table VII shows the result.)

TABLE VII

EFFECT OF DRILL ON GAINS IN SKILL AND IN FUNDAMENTALS
(J. C. Brown)

	Experimental Group	*Control Group*
Number of problems worked	21.2	9.8
Addition	33.4	11.8
Subtraction	36.9	13.1
Multiplication	30.0	13.7
Division	28.0	19.3
Total number points made	32.0	14.7

The enormous influence of repetition plus intensity is shown in this table wherein by means of rapid fire drills more than twice as much improvement took place as in the ordinary arithmetic computation where the examples were repeated but with less intensity than in the drill work.

e. *Integration and Organization.* The integration of arithmetic habits into higher units continues from the very beginning of the learning process, thus, much that is learned in long division consists in organizing the habits of addition, subtraction, multiplication, and short division into a working unit. Short-circuiting processes are continually appearing all along the line. Pupils who add

$$\begin{array}{r}29\\34\\16\\58\\\hline\end{array}$$

may say at first 8 and 6 are 14 and 4 are 18 and 9 are 27, but as they gain more facility in adding they see 8 and 6 and think 14 immediately almost without any intervening consciousness. They then on seeing 9 plus 4 think immediately "13" and finally on considering 14 and 13 at once think "27." All of which takes place much before one can read the account of it.

4. Spelling

Desirable mental set towards spelling is comparatively easy to attain because the record is so objective and verifiable. Furthermore, the need to correct spelling can be easily shown. It is quite simple, too, to introduce group rivalry which is an aid in creating a desirable attitude towards correct spelling.

The selection of the correct responses and the elimination of the undesirable ones are aided by the objectivity of the response. Experimental evidence (Pearson) is clear on the efficacy of getting the teachers to direct the child's thought to the more difficult letters in the word. In long words these difficult ones tend to be those near the middle. Making these desirable letters more intense by varying devices such as colored chalk, enlarged letters, etc., seem to aid in selecting the correct sequence of letters. Great attention has been given to the discovery of the causes of errors in spelling in order that assistance may be given in eliminating them.

Some find that errors of perception both in hearing and seeing are important causes of errors in spelling. The evidence is accumulative that errors in auditory perception are highly significant. These deficiencies occur largely because of poor pronunciation and to a lesser extent because of lack of acuity in hearing. Lack of clear visual perception seems to affect the spelling particularly of long words. Carelessness, too, exacts its toll of misspellings, producing about 20 per cent of them. It is possible to attain more accurate perception by first having the word pronounced by the teacher, then by the child, and then by getting the child to write it down. Further aid appears in teaching the meaning of the word at the same time. It thus seems clear that the selection of the desirable spelling and the elimination of the undesirable one is of first rate importance in instruction in this subject.

The fixation of the proper sequence of letters is one of the most difficult goals to attain in elementary education. Use, or repetition, stands us here in good stead provided there is intensity. Mere repetition seems of little use as in the case of the child who, copying a misspelled word, after about the tenth rewriting, began to spell the word incorrectly. One intense experience of either pleasant or unpleasant nature may fix the correct spelling for all time. Most important of all is intensity at the point at which the error has been made.

There is probably very little organization among spelling habits though certain root words are spelled alike wherever found. The difficulty here is that when one's experiences are becoming organized, exceptions occur at such a rate that one cannot further proceed with the integration of habits. This inability to organize spelling habits may account for the difficulty of forming and retaining the connections.

5. History

In learning the events of history, a body of experiences connected with the past must be built up through the imagination. The process is an orderly one, involving set, selection and elimination, fixation, and integration. Connections must first be formed between the present events and those of the past. The learning is more difficult because history always involves the development of the sense of time which appears very slowly in the average child. Hardly does the child distinguish clearly between morning and afternoon by the time that he is old enough to enter school. Connections must be formed between the manners and customs of then and those of now; between differing modes of travel, and differing means of communication. In his imagination he must construct a different world from verbal descriptions of those times, from dramas, from pageants, and from pictures. Connections must be formed between ideas and between these and other ideas until an orderly system of events is comprehended. This orderly sequence is probably best developed at first through the lives of interesting heroes; second, through state history; and third, through national history. The threads to be traced through, may be political, industrial, or economic. Thus, sequential bonds, such as the tracing out of the influence of slavery, must be formed. Frequently, even more complex connections such as those resulting from the interaction between slavery and political opinion must be made. Finally, bonds must be formed between present institutions and their pasts so that the continuity of our institutions can be thoroughly understood.

A good illustration of the manner in which intensity and repetition may work together appears in the many bonds which need to be formed with 1453, the date of the fall of Constantinople, i. e., if this is to become a significant date in the minds of the pupils. For there had gathered in this wonderful city Greeks who still held on to the traditions of science and philosophy of ancient Athens. Moreover, lanes of commerce fostering a great interchange of desirable commodities between the East and the West passed through Constantinople. When it fell to the Turks in 1453 these Greek scholars were scattered throughout Christendom. Wherever they went they stimulated an interest in Greek learning and were undoubtedly helpers in stimulating the movement of the Renaissance. The fall of Constantinople blocked up these lanes of commerce. This made the dwellers in the West seek new ways to the East. One of these bold adventurers struck out towards the South, and rounded the Cape of Good Hope; but another, more bold still, turned the prow of his ship westward hoping to arrive at the East and discovered a new continent and thus there is little question but that the discovery of America was directly related to this other important event in the history of the world. It thus seems clear that if the object is to make a date significant and worth while many types of connections must be formed. The law of use is here not of first importance but rather the law of intensity for to memorize "In 1453, Constantinople fell" by repeating it, twenty times would simply be the formation of meaningless connections. What is necessary is for numerous bonds to be connected with this event, and while each of these may have "Fall of Constantinople in 1453" as a response the repetitions are gained in a manner full of interest, a condition closely akin to satisfaction.

6. Appreciation of Poetry

The same laws which apply in motor and informational learning apply also in emotional and affective learning, but the emphasis is different, for the establishment of the attitude becomes, in developing appreciation, of major importance. This attitude it is hoped will be tinged with a pleasant feeling tone. In the study of poetry we have an excellent illustration of how a feeling tone may be learned. When we approach a poem such as Burns's "To a Mouse," we take great pains to clear away all difficulties of new words and of unusual phrases. We arouse in the child's mind experiences similar to those in the poem by asking him questions about his contacts with mice. We then recount some of our own experiences with these tiny creatures. In every way possible we prepare the child's mind for the appreciation of the poem. When all this is done we read the poem aloud to the child so that he may get the full significance of it. He may miss some of its philosophy but will most probably catch its spirit, and feel with Burns more deeply for dumb animals. Nothing must be done in connection with the poem which might cause annoyance. There must be no meticulous analysis of the words, nor a too long nor penetrating study of it. If the teacher has caught the spirit of the thing and actually loves literature there is still further chance that a pleasant feeling will be attached to the poem. Moreover, if the teacher comes back to the poem once or twice during the year or even the next year, the experience is apt to be pleasant for the pupil. In poetry as in music there is nothing quite so pleasant as to come across, rather suddenly to be sure, a fine old poem with which one is familiar. Certainly such opportunities to become fond of the masterpieces should not be neglected.

In this illustration a mental attitude is attached to a poem which previously it did not have. This is done by arousing pleasant experiences in the mind of the child either through the poem's rhythm or unusual word sounds, or more probably through connecting up the experiences of the poem with those of the child. If, perchance, the child has had similar experiences and has responded to them pleasantly, then the forming of the connection between past experiences and the present through the agency of the poem are made more easy. That is to say, the *poem* arouses experiences which before had been aroused by direct experience with the actual objects. If the child has had parents who have read aloud to him, who have developed his imagination, and called his attention to beautiful things, the shift of attitude is not so difficult.

From this explanation it is clear that the selection of poems appropriate for the various grades is a matter of surpassing importance. The most successful way to do this is to present to the children in the different grades poems of a varying nature and then to get a census of their opinions. Furthermore, it would be worth while for teachers and parents to know what is going to be taught the child during the following year and to strive to see to it that the children obtain a background for the poems which are to be studied.

Enlarging the Vocabulary

The growth of the knowledge of words offers an interesting illustration of the forming of specific connections by means of intense repetitions. Figure 14 shows the marked rapidity with which young children acquire the use of words. Note particularly the rapid rise between years one and two. This graph is not comparable with Figure 15 because the former is a measure of the number of words used, while the latter is a measure of the number of words defined. In the latter case (Stanford Revision) the words were selected from a certain part of a page of a dictionary and hence are "unselected" in the technical sense of the word. By this is meant that the words were not chosen for any particular purpose but were taken as they came. Since they are chosen in this manner

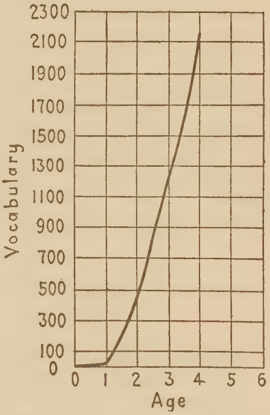

Fig. 14.—Average vocabulary at the different ages. Figure drawn from averages computed by Waddle and reported in his *Introduction to Child Psychology*, 1918, p. 166.

they are more highly representative of words in general than they otherwise would have been. We will note that in this case there is a gradual accretion of words from year to year. The rate of growth seems to remain steady from year to year. We can feel very confident that if the vocabulary of an eight year old is twenty words on this test when he arrives at ten years his vocabulary will not reach much beyond thirty. In brief, while this is an average at the separate years the general shape of the curve differs but little from the type of curve a normal individual would have had if he had been consecutively measured. Baldwin has shown this in (1) height curves and (2) mental age curves. Vocabulary curves offer capital illustrations of the formation of bonds between words and their meanings and between words and their use.

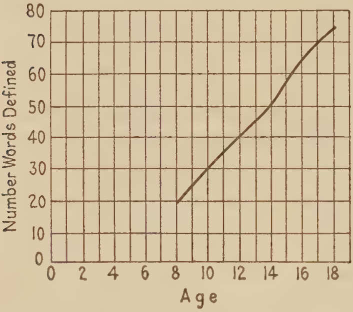

FIG. 15.—Number of words defined by children at the given ages. The scores taken are the standards set up by the Stanford Revision of the Binet-Simon tests and they represent the number defined out of the 100-word vocabulary especially constructed for that test. To get total vocabulary multiply number of words by 180.

LEARNING CURVES FOR SCHOOL SUBJECTS

Figures 16 to 20 portray the learning curves of the average of several children in reading, spelling, and arithmetic. In two cases, spelling and reading, we have comparable results obtained at widely different times, in different grades, and from different tests. In spite of all these differences the curves show rather striking similarities. For example, in each there is a rather gradual rise in the curves which is unlike that which occurs in those for simple motor habits

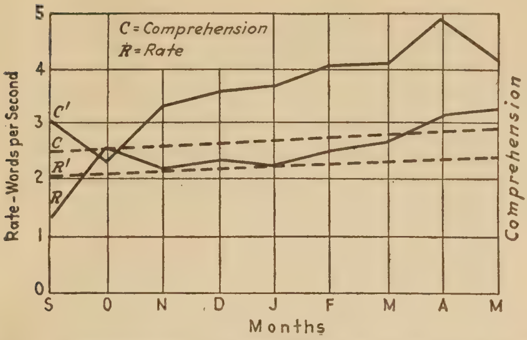

FIG. 16.—Improvement of twenty-five fourth grade children from September to May in speed and comprehension in reading as measured by Starch reading tests. Standard September and June scores for these tests are shown by dashed lines. (Henmon, 1920.)

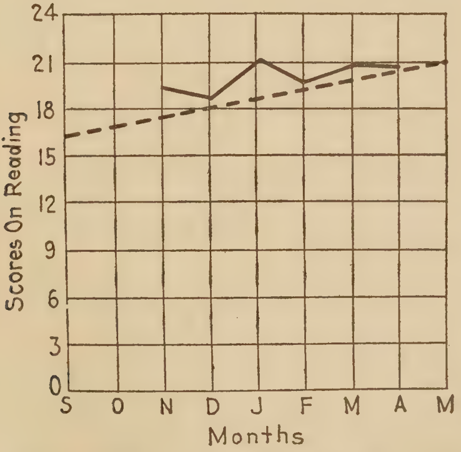

FIG. 17.—Improvement of seventeen fifth grade children from November to April in reading as measured by the Thorndike-McCall tests. Standard September and June scores shown by dashed line.

such as sending messages in telegraphy. In these school subjects there are so many habits to be formed that frequently the advance of one is the retreat of the other. But here we do have the learning curves of children in a normal schoolroom situation in their subjects of instruction. There seem to be very few plateaus, at least none that last over a period of a month. It is evident in all the curves, though, that there is much more rapid improvement at some times than at others.

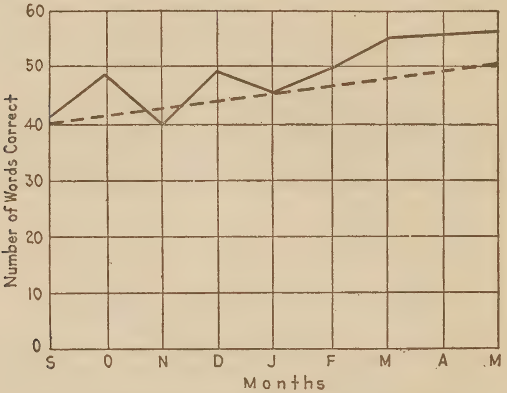

FIG. 18.—Improvement of twenty-five fourth grade children from September to May in spelling as measured by the Starch tests. Standard September and June scores shown by dashed lines. (Henmon, 1920.)

In Figure 16 from September to October there is a drop in comprehension but an increase in speed. From November to March the improvement is gradual, but in April there is an acceleration in both comprehension and rate. When we compare these curves in fourth grade reading with those in fifth grade reading, Figure 17, we find in the period from November third to December third a falling off in reading comprehension. (This result may have been due to the lack of the complete coöperation of the pupils.) Aside from this rather unusual depression the curve rises gradually. In spelling, the curves rise rather irregularly, but in both grades IV and V there is a gradual upward trend.

In addition (Figure 20), we have a much more rapid rise under the more or less experimental conditions which prevailed in this study of the learning curve. But even here there is a steady upward trend of the curve. No sudden insights cause a rapid rise but the whole curve is a picture of gradual growth. The one time when the results of teaching loom greatest on the score is between February and April. January and February seem to be a period of little seen improvement. It is possible that the bonds in addition are

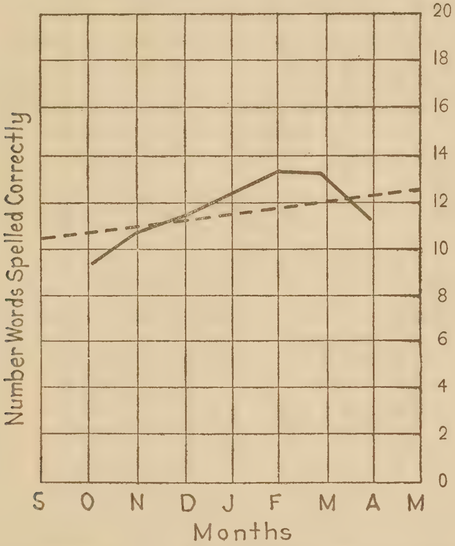

FIG. 19.—Improvement of sixteen fifth grade children from October to April in spelling as measured by Trabue's arrangement of the Ayres scale. Standard September and June scores shown by dashed line.

not so numerous as in reading and spelling and hence are repeated a larger number of times and thus are more susceptible to improvement. In the results reported in these graphs the scores were used as definite incentives to improve the scores in the subject of instruction. In one case at least (fifth grade) the curve of improvement of the class was posted from month to month. While these curves show us the general trend of the learning curves, they fail to make clear the enormous individual differences in growth which are more important for matters pertaining to classroom instruction.

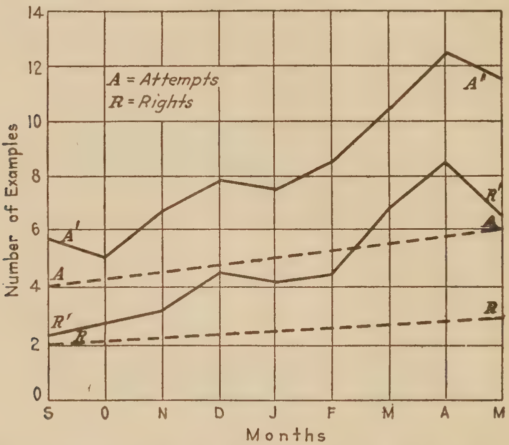

FIG. 20.—Improvement of twenty-five fourth grade children from September to May in addition as measured by the Courtis scale. Standard September and June scores shown by dashed lines. (Henmon, 1920.)

SUMMARY

The laws of learning are adequate to explain the learning process involved in the elementary school subjects. It could also be shown that they apply just as well to high school and to college subjects. Indeed they seem adequate to explain all phases of learning.

In handwriting the visible type of response makes the attachment of satisfaction and annoyance to the simpler processes such as manner of holding the pen, arm, the position at the desk, etc., somewhat easy. But the more complicated bonds connected with the integrating of habits into a smooth-running unit is less evident and the correct bonds more difficult to select. Handwriting charts analyzing the habits are useful in facilitating the formation of the simpler processes and writing in rhythm aids the smoothness and speed. Reading is rich in illustrations of set since the general attitude of pupils towards reading and the specific sets connected with the reading of paragraphs have both been carefully studied. The process of integration is also well known since, by means of eye movements three habits have been traced from the first grade through college. Arithmetic offers peculiarly good illustrations of the laws of repetition and intensity since the learning process has been carefully analyzed and it is thus a simple matter to apply the repetition at just the point where it is needed. By means of this procedure greater visible improvement per unit of time expended is produced in the fundamentals of computation than appears in any other school subject. History offers a somewhat different problem from the other school subjects treated since so many bonds have to be formed with unseen objects and events with which the child has had little experience. The concept of the passage of time is also slow in developing. In this subject, of great importance is the use of intensity as an aid in forming meaningful connections. Spelling offers a case where most of the bonds are specific with little organization or integration of experiences: while the appreciation of literature is interesting because it consists of the formation of a favorable attitude towards a poem or story.

QUESTIONS AND EXERCISES

1. Compare the learning of handwriting with that of reading.
2. Explain precisely why the process of selection and elimination of bonds in handwriting in most cases is a comparatively simple matter.
3. What assistance does Freeman's Handwriting Chart give the teacher of handwriting?
4. Explain the importance of mental set in reading. Note carefully errors in mental set in reading which have occurred in your own case.
5. Trace the course of the reading habits through the grades as revealed by photography. What is the general shape of the reading curves? What does their shape argue concerning the importance of reading habits in the first four grades?
6. Get a six or seventh grade child to add aloud for you. Look particularly for curiosities of habit formation and report the results to class.
7. Why is the study of errors so important in habit formation? Give Woody's Arithmetic test to a fifth grade class and classify the errors the pupils make. Report results to class.
8. Describe carefully how the meaning of numbers is acquired.
9. How can you make the correct letters in spelling more intense? Would you write on the board the wrong form? Why?
10. Discuss the importance of the influence of correct pronunciation on spelling. Why is spelling so difficult to improve? What sort of words should we teach the pupils to spell?
11. How does the learning of history differ from the learning of reading? What aids can you think of which will help the child's perception in the field of history?
12. Of what advantage would the socialized recitation be? Just what is the importance of developing meaningful connections?

13. How could your knowledge of conditioning of a response be applied in teaching the appreciation of a poem?
14. How does the curve of learning vocabulary compare with learning telegraphy? With learning reading, with improvement in spelling? Are the bonds different or are the measuring instruments different? Explain.
15. What is the general shape of learning curves for school subjects when these curves are based on the successive measurements of a class by standardized tests? What determines the shape of the curve?

REFERENCES IN THE PSYCHOLOGY OF THE ELEMENTARY SCHOOL SUBJECTS

General References

Cameron, E. H. *Educational Psychology*, pp. 293–438, 1927.

Freeman, F. N. *Psychology of the Common Branches*, 1916.

Reed, H. B. *The Psychology of the Elementary School Subjects*, 1927.

Starch, Daniel. *Educational Psychology*, Revised edition, Part III, 1927.

Handwriting

Freeman, F. N. *The Handwriting Movement*, 1918.

Freeman, F. N. and Dougherty, Mary L. *How to Teach Handwriting*, 1923.

Gates, A. I., and Taylor, G. A. "Acquisition of Motor Control in Writing in Pre-School Children," *Teachers College Record*, Nov., 1923.

Reading

Buswell, G. T. *Fundamental Reading Habits: A Study of Their Development*, 1922.

Dearborn, W. F. *The Psychology of Reading*, 1906.

Gates, A. I. *The Psychology of Reading and Spelling*, 1922.

Gray, C. T. *Deficiencies in Reading Ability*, 1922.

Gray, W. S. *Summary of Investigations Relating to Reading*, 1925.

Huey, E. B. *The Psychology and Pedagogy of Reading*, 1908.

Stone, C. R. *Silent and Oral Reading*, 1922.

Thorndike, E. L. "Reading as Reasoning: A Study of Mistakes in Paragraph Reading," *Journal Educational Psychology*, 1917, Vol. *8*, pp. 323–32.

Arithmetic

Brown, J. C. "An Investigation on the Value of Drill Work in the Fundamental Operations in Arithmetic," *Journal Educational Psychology*, 1911, Vol. *2*, pp. 81–88; 1912, Vol. *3*, pp. 485–492, 561–570.

Buswell, G. T., and John, Lenore. *Diagnostic Studies in Arithmetic*, 1926.

Buswell, G. T., and Judd, C. H. *Summary of Educational Investigations Relating to Arithmetic*, 1925.

Counts, Geo. Sylvester. *Arithmetic Tests and Studies in Psychology of Arithmetic*, 1917.

Dewey, John, and McLellan, J. A. *Psychology of Numbers and Its Applications to Methods of Teaching Arithmetic*, 1895.

Osburn, W. J. *Corrective Arithmetic*, 1924.

Thorndike, E. L. *The Psychology of Arithmetic*, 1922.

History

Horn, Ernest. "Possible Defects in the Present Content of American History as Taught in the Schools," *Sixteenth Yearbook* of the National Society for the Study of Education, 1917, Part I, pp. 156–172.

Johnson, Henry. *Teaching of History*, 1915.

Rugg, H. O., Earle, N., and Schweppe, Emma. *The Social Science Pamphlets*, Second edition, 1922–1925.

Spelling

Hollingworth, L. S., and Winford, C. Amelia. *Psychology of Special Disability in Spelling*, 1918.

Horn, Ernest. "Principles of Method in Teaching Spelling as Derived from Scientific Investigation," *Eighteenth Yearbook* of the National Society for the Study of Education, Part II, pp. 52–73, 1919.

Pearson, Henry Carr. "Experimental Studies in the Teaching of Spelling," *Teachers College Record*, Part II, 1912.

Literature

Dunn, F. W. *Interest Factors in Primary Reading Material*, 1921.
Eastman, Max. *The Enjoyment of Poetry*, 1913.
Leonard, S. A. *Essential Principles of Teaching Reading and Literature*, Chapter VIII, 1922.

CHAPTER VI

HOW TO STUDY

Investigations of the methods of study of pupils or students whether in the third grade, high school, or university clearly show a variety of weaknesses. A few students after due process of trying half a dozen, have selected efficient methods. The majority has not. One of the greatest difficulties seems to be in understanding the meaning which is to be conveyed from the written page, and in seeing the significance and implications of what is read. Thus like Hamlet, who on being asked what he was reading answered, "Words, words, words," is many a student who seems to be not infrequently reading only words. A teacher of ancient history on one occasion asked one of her pupils a question concerning this subject. This boy seemed to enjoy answering the question for he started off along a line which to the teacher's ear seemed strangely familiar but, rather suddenly to be sure, stopped at just the middle point of a sentence and seemed absolutely unable to proceed further. Later, on glancing at the book, the teacher saw immediately that the pupil had memorized all of the first page and that since it stopped in the middle of a sentence so did he. While this is probably an extreme case such methods of study are far too frequent.

Some of the More Common Types of Errors in Methods of Study

1. *Merely Reading.* It would seem that those who know how to read could by pursuing this activity learn very quickly and thoroughly. But there is so much to be read that some-

times material passes before a student's mind so rapidly that it makes little impression. Frequently, too, there is little background of similar knowledge to which to attach this new material. It thus passes unreacted to and unlearned. This method leaves out one of the most important principles of learning, that of reacting.

2. *Cramming.* Among pupils in high school and university perhaps cramming is the most vicious type of error in studying. Cramming means, of course, the attempt to learn a great deal in a very short space of time, to learn in such a way that the facts acquired can just possibly be recalled on one occasion. One is almost tempted to say that if a person wishes to forget what is learned in the shortest time possible, cram it up.

3. *Working without a Plan or a Purpose.* A vast deal of time is wasted in studying because the individual fails to plan his work to attain a certain end or goal. The lack of plan or purpose is one of the causes for merely reading. The planning of work insures the proper distribution of time for each subject and a definite time for its study, i. e., if the plans are carried out.

The purpose insures that the new material will be reacted to in the light of this purpose—or mental set. The purpose helps decide which phases of the subject are of most value, and which phases shall satisfy.

4. *Learning Part by Part.* Untutored learners on attacking new chapters or new poems are apt to learn them part by part, the immediate success of which is apparent. Recent investigations have shown that, for certain sorts of material, this procedure is probably incorrect and that reading all the way through the material to be mastered is better for permanency and broad meanings.

5. *Accepting Uncritically the Statements of the Book.* The writer of a text is so far ahead of the learner in knowledge of the material contained in it that there is a tendency for the

student to accept on faith the material presented. And yet, this attitude of mind is undesirable. Students should always read with such questions as these: Does it fit in with my past experience? Can I find any errors in it? Is there another possible way of interpreting this? Does the inference really follow from the data presented?

6. *Working at the Solution of New Problems in an Inefficient Manner.* Sometimes in study a student is called upon to attack a new problem: to solve an original in geometry; to organize material in a new way; to discover the answer to a question. This type of problem solving is reasoning, the most difficult of all of the types of study. Students fail in this type of undertaking because of a lack of specific training for it.

7. *Working at a Low Level Physically and Mentally.* Very few individuals because of slight physical deficiencies are able to study at 100 per cent efficiency. Insufficient sleep, inadequate recreation, too much dissipation of a mild sort, compel students in many cases to work at 70 per cent efficiency instead of at 90 to 100 per cent.

1. Merely Reading

The proper sort of reading requires reasoning as well, requires the fitting of experiences being acquired into those already acquired. For example, it requires the gaining of a certain mental set from a part of the paragraph and then a careful scrutiny of the rest to be convinced that this adjustment is adequately maintained. Reading then in one sense may be regarded as reasoning. On the other hand, no merely peaceful absorption of the words of the printed page may be justly regarded as reasoning. One of the most helpful ways to insure reaction to and consequent learning of the material studied has been the use of recitation in learning.

The Method of Recitation. The recitation introduced at various stages in reading has demonstrated beyond cavil its value. Its chief advantages consist in calling attention to the errors in the early stages of habit formation before the wrong responses have been definitely fixed. The correct response is then substituted for the incorrect one and satisfaction may be attached to the correct one. For example, errors in the understanding of a historical event may be prevented from being firmly established by frequent reference to the proper source of information. Moreover, if an individual knows that as soon as he has gone over this lesson he will be required to recite it he reacts more strongly to its elements and to its meaning. A teacher tried this out one day by arranging in two sections material of equal length and difficulty. On one day, one section of this work was given to a class with no instructions, and on the next day the other section was presented, with the strict admonition that the substance of it was to be called for within the next day or two. There was much more material remembered by the pupils when they knew that they were going to be questioned about it. The influence of the method of recitation is clearly illustrated in an experiment by Gates.

The results of this experiment with school children of grammar grade level are given in Figure 21. In this combination of graph and table the amount learned through reading alone is always taken as 100 and the increase in efficiency due to increasing amount of recitation is expressed in terms of this 100.

From Figure 21 certain deductions concerning the value of introducing recitations in learning can be made.

1. Recitation is undeniably better in both sense and nonsense material in both immediate and delayed recall.

2. The advantage is much greater in delayed recall than in immediate recall. This is a factor of great importance, for this means greater permanence.

3. The advantage is greater in nonsense material than in sense material. Most probably all reading is interspersed

with recitations at intervals of various lengths and hence it is more difficult to control experimentally. In fact as Gates suggests pure reading without recitation may be a fiction.

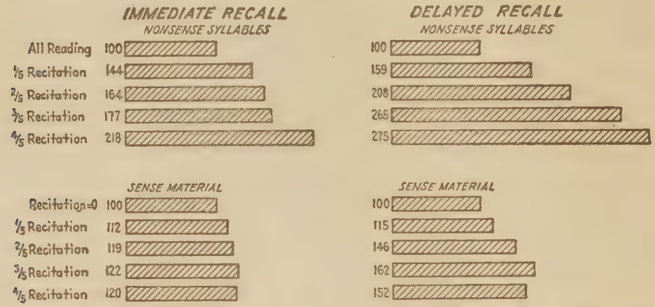

FIG. 21.—The effect of using recitation in learning. The bars are drawn with "learning by reading" used as a basis of Comparison, as 100. All the other methods are compared with this one. The time for study was nine minutes. The material used consisted (a) for sense material, of short biographies, and (b) for nonsense material, of nonsense syllables. Grades IV, V, VI, and VIII furnished the subjects. "Delayed recall" means "after four hours." Note particularly that by using the recitation method one can double his efficiency in learning nonsense material and increase it over 20 per cent with sense material. (Data from Gates, A. I., *Recitation as a Factor in Memorizing*, 1917.)

4. The relative amounts of reading and recitation for all types of material were not determined but this experiment would imply that more time may profitably be given to the recitation than to the reading. In sense material as much as three-fifths of the time may be profitably allotted to the recitation.

There are good reasons why the recitation injected into the process of reading is helpful in learning. The learner is able to correct errors in habit in the early stages of their formation. Repetition has not yet fixed these errors firmly enough for them to offer much resistance to their uprooting. Furthermore, the learner can feel satisfied that he does know certain phases of the material and he can be just as certain that he does not know the other parts of it. He is thus enabled to center his studying on spots where the results will be greatest. Finally, he learns the material in the same way that he is going to use it. The amount of transfer required, therefore, is a minimum. Woodworth [1] says of the recitation: "Whence comes the advantage of recitation? It has a twofold advantage: it is more stimulating, and it is more satisfying. When you know you are going to attempt recitation at once, you are stimulated to observe positions, peculiarities, relationships, and meanings, and thus your study goes on at a higher level than when the test of your knowledge is still far away, with many readings still to come. You are still stimulated to manipulate the material, by way of grouping and rhythm."

Merely reading is thus uneconomical as a method of learning both for immediate use and for future use. It fails to keep us on the *qui vive*, to demand constant watching for meanings, in brief to give us a reaction. For the younger student especially, one whose learned reactions are not so numerous, whose problems are rather scarce there needs to be a constant checking up of his supposed acquisitions by means of the recitation.

2. Cramming

By "Cramming" is meant the hurried repetition in a very short period of time of a large amount of material in order to pass a written test upon it. The ability to gain a great deal of half understood knowledge in a very short period of time may under certain circumstances be an asset. To the lawyer working up a case, details of which are needed for only a short period of time, such an ability might be a godsend. But as a method of learning it is all wrong. Wrong, because time is always necessary for connections to be formed thoroughly. Many meanings which did not appear at first may do so after a period of time and it is these very meanings which give permanence to connections which have been formed. Experimental evidence bears out the reasoning mentioned above.

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[1] *Psychology*, 1921, pp. 340–341.

Distributed versus Concentrated Learning. Pieron's experiments in varying the time between repetitions resulted in definite advantage to distributed learning, i. e., the longer the interval (up to certain limits) the shorter the time required for learning. One minute was a better interval than a half a minute; two minutes was better than one minute, and

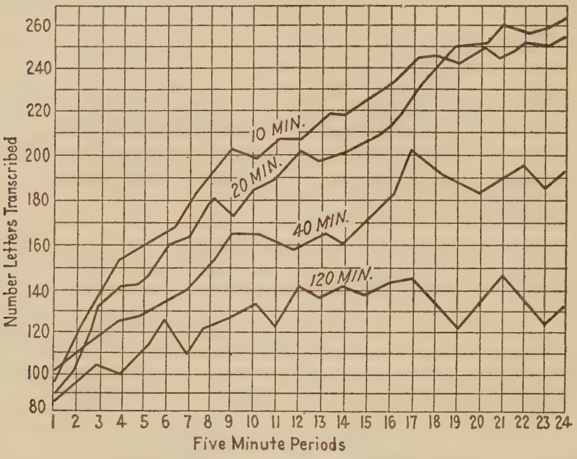

Fig. 22.—Shows the effect of the distribution of work on learning to substitute numbers for letters. The statement "10 min.," means the group worked ten minutes twice a day for six days; "20 min." means that this group worked twenty minutes at a time once a day for six days; and "40 min." means this group worked forty minutes at a time every other day for six days. The designation, "120 min.," means this group did the entire task at one sitting. (Starch, Daniel, *Periods of Work in Learning*, 1912.)

five minutes better than two minutes. After twenty minutes the length of interval up to 48 hours did not matter much. One subject took 11 repetitions to learn the series of items with a half minute interval, 8 repetitions with two-minute intervals, 6 repetitions with five-minute intervals, and 5 repetitions with intervals varying from 1 to 48 hours. Similar results were obtained from two other subjects.

The same advantage for distributed learning also appears in Ebbinghaus's earlier experiments as well as in those of Starch (Figure 22).

More recently still, experiments by Reed have shown results similar to Starch's. Reed's findings are notable for the number of pupils concerned and for the fact that he approached the problem in a doubting frame of mind. Two hundred three first and second year college students worked one hour in adding problems of 2-place numbers having no zeros. The hour was distributed as follows:

Group 1. 60 students added 1 hour continuously.
Group 2. 50 students added 20 minutes a day for 3 days.
Group 3. 51 students added 10 minutes a day for 6 days.
Group 4. 42 students added 10 minutes twice a week for 3 weeks.

TABLE VIII

EFFECT OF THE DISTRIBUTION OF TIME ON LEARNING
Adding 2-place numbers(Reed, 1924)

	Attempts		*Gains*		*Rights*		*Gain*	
	First 10 m.	*Last 19 m.*	*Absolute*	*Relative*	*First*	*Last*	*Absolute*	*Relative*
Group 1—60m.	42.9	47.	4.1	10.9	40.	44.7	4.7	12.2
Group 2—20m.	43.7	58.4	14.7	35.9	40.7	56.4	15.7	43.4
Group 3—10m.	47.2	62.7	15.3	33.1	46.3	59.8	14.9	33.6
Group 4—10m.	45.1	59.7	14.6	28.6	42.3	57.2	14.8	35.1

The table and graph show the great advantage of distributing time rather than of concentrating it. Any manner of distribution seems better than using it all at one sitting. The 20-minute period proves to be highly efficient and surpasses all others arrangements in both absolute and in relative gains. Twenty minutes once a day, therefore, seems to turn the trick as far as economy of learning arising from the distribution of time is concerned.

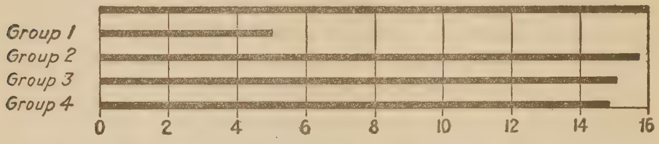

Fig. 23.—By using the absolute gain for each group, it is seen that Group 2 (twenty minutes a day for three days) surpasses the others. The figures are taken from Column 7 of Table VIII and represent the effect of distributing an hour's time in four different ways. See text for the description of the different groups.

Several other experiments, moreover, have turned out in a similar manner to the one mentioned above. Hahn and Thorndike in investigating the optimum lengths of practice period found (contrary to Kirby's results who had found that 2-minute periods were best) that 22½-minute periods were best with 5th, 6th, and 7th grade children in improving addition. The reader will note that 22½-minute intervals proved the best, findings similar to and not contrary to those quoted above. In addition, Wimmer's results that 15 minutes' weekly practice is superior to 5 minutes' daily drill in arithmetic problems, it seems to me, simply agree with the 20 minute unit. At least his results are not in opposition to the findings of Reed, Thorndike, Hahn, and Starch (Figure 22). In conclusion, distributing time over a long period is a more efficient method of learning than concentrating it in a short one. Rich meanings, greater permanency come only from the consideration of material from time to time. President Eliot used to say that he read the plays of Shakespeare each year in order to keep in close touch with their author and that frequently he would discover new meanings in their writer's words at each repetition. Experienced physicians are those who have not only learned about diseases but who have time and again come across the same disease. It takes continued return to any material to learn it well.

The principle of the distribution of practices in learning has a useful application in the suitable distribution of reviews. In the beginning stages of habit formation the rate of forgetting is extremely rapid and unless repetitions are made very soon after the period of initial learning the greater portion of what has been learned is forgotten. Figure 24 is a curve of forgetting which represents its general trend when the material in question is of a meaningful nature. (Cp. also Figure 7 on p. 82.) The rate of forgetting

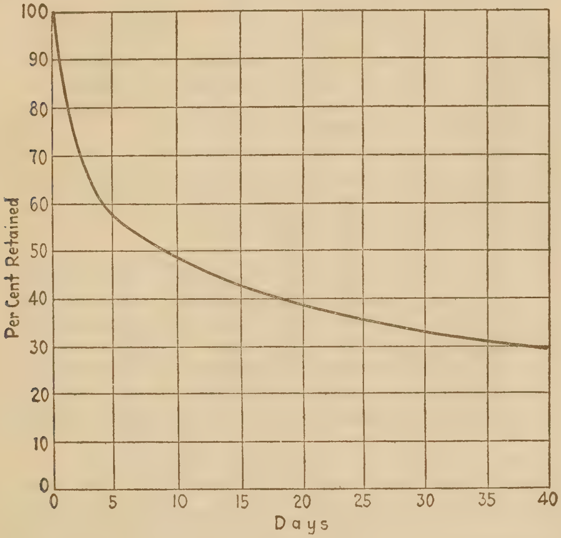

FIG. 24.—Typical curve of retention for meaningful material.

is dependent upon other factors, too, besides the nature of the material. If an individual has used the method of recitation in learning, the curve drops off more slowly. If the periods of learning have been distributed during the learning process rather than concentrated, if the repetitions in learning have been more than ample for one correct recall, the curve of forgetting is thereby affected. But in any and all cases the forgetting is rapid enough and if any considerable portion of what is learned is to be retained provisions must be made for reviews. Figure 25 shows the general principle of the concentration of reviews in the earlier stages to prevent the process of rapid forgetting and then the placing of them further and further apart.

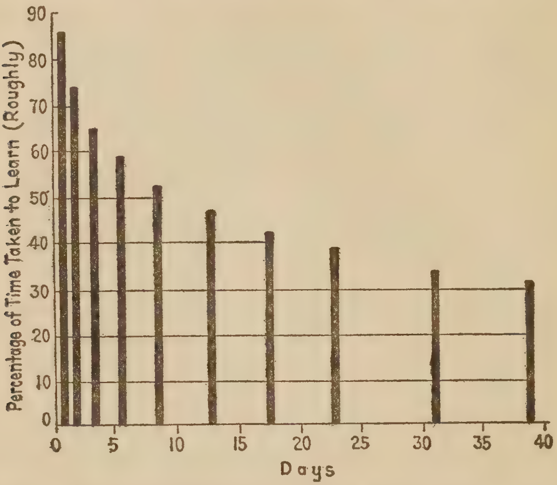

FIG. 25.—Shows distribution of reviews necessary to compensate for the rapid forgetting in the earlier stages. The height of the columns represent the relative amount of reviews, and the distance between columns, the amount of time elapsing between reviews. The exact amounts have not been computed for the various school subjects but the general principle holds.

Some attempt has been made to take this principle into consideration in the use of the spiral plan of instruction. This plan has the student come back to certain types of knowledge time and again but at each succeeding time on a little higher plane than at the preceding one. On the other hand, many textbooks in the elementary school and in the high school make little provision for satisfactory reviews. In history and geography particularly, in which subjects the number of items to be learned is enormous, is it extremely difficult to provide for adequate reviews.[1] For adequate learning, for the mastery of subject matter provisions must be made for reviews in such a manner as to counteract the process of rapid forgetting at first and to provide for reviews at such intervals as to insure mastery over the desired material.

3. Lack of Plan or Purpose

One of the most distinguishing characteristics of Homo Sapiens in contradistinction to the lower animals is his ability to plan, the ability to analyze carefully the happenings of the past and the events of the present and to project the lessons learned into the future. The best type of planning is that done by the pupil or student himself when he makes careful inventory of his own time and plans his daily work to gain certain desirable ends. A plan has many advantages. It prevents waiting when one task is done to turn to a new one. Haphazard, profitless work is no longer necessary but work is performed to fit in with a plan. One remembers better, sees greater significance in the material learned, is happier in his work, and profits more in every way. It thus seems clear that if one wants to live and work effectively, if he wants to have time for work, recreation, and contemplation, he must plan for each day's work and for the future in general.

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[1] For an interesting discussion of this matter see Reed, H. B., *Psychology of Elementary School Subjects*, 1927, pp. 362–365.

The following quotation gives a clear notion of the advantages of planning, "Recently the writer spent an evening with a very successful and skilled surgeon. It was the night before he had to perform a difficult operation. He got out and tested about one hundred instruments, every kind that he thought he might need. These were all arranged on a table in a certain order and each one tested to see that it was in perfect working condition. He even decided upon a particular arrangement of these instruments so that he would know where to reach if a particular kind was needed. He did the same thing for the other materials he would need. He carefully reviewed a specially selected set of drawings of the anatomy of the parts to be worked upon the next day, and consulted some of the best authorities covering not only the operation itself but the emergencies which had been reported in past operations of this particular type. He reviewed in his mind his own experiences with operations of this same general sort and stated to the writer what would be the best thing to do under each of the conditions that might arise. He even outlined and reviewed the exact steps to take in the performance of this very difficult task, which, by the way, he had performed many times before. The actual operation the next day was no more skillfully performed than it had been accurately planned and thus mentally reviewed the evening before. And it should be stated that the patient's life was saved the next day by one of the emergency devices which this surgeon had so carefully planned for and had ready at hand when the emergency arose." [1]

In studying and working effectively there must always be a time to study and a place to study. These two are essentials for success.

Time to Study. Probably no one thing is more important for successful study than a certain time to devote daily to each subject. Lessons vary in length and difficulty and undoubtedly require sometimes twice as much in one case as in another, but still these differences should be allowed for and a definite time in the daily program arranged for the study of each lesson.

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[1] Book, W. F., *Learning How to Study and Work Effectively,* pp. 199–200, 1926. Ginn and Company.

A Place for Study. A quiet desk with droplight and other convenient accessories each one should possess. If quietness is impossible a place for study will help in getting the right set towards study. Some have found a place to study very helpful if they never permit themselves to do anything else at that place. If a friend comes in they move the chair away from the desk or sit in a rocker but never carry on a conversation about trivial things while at their study desk. Practice in this procedure makes it easy to turn quickly from recreational laughter and conversation to the more serious task of studying.

4. Learning Part by Part: The Whole Versus Part Method in Learning

The Part Method. The method of learning ordinarily fallen into by the undirected learner proceeds by first learning one part of the material before him, then by adding another part to the first one and so on until the whole has been mastered. This method is most probably faulty in several particulars. The first section repeated in turn with each of the others gets repetitions far in excess of the necessity for learning. Like the opening lines in the House that Jack Built the monotony of the first part becomes quite deadly. Thus the young child bravely starting on its first declamation voyage lands on the rocks in the latter part of it. In poetry, associations are formed between the beginning and end of the stanza so that the child once begun on the right stanza goes tripping to its end but cannot begin the next one. Too many repetitions of the first parts of the learning material, artificial associations, and improper intervals between successive repetitions as pointed out in the previous paragraphs, then, are some of the difficulties with the part method. These weaknesses produce rather disastrous results, to be sure. Connections formed only artificially, like nonsense syllables, weaken rapidly; bonds formed with insufficient time for them to become mature suffer the same fate. Such considerations as these have led psychologists to attempt to find some better way which might lead to more meaning, fewer artificial associations, and a greater permanence of material studied.

The Whole Method. The whole method consists in studying much larger units of material than does the part method. Instead of learning a poem, for example, stanza by stanza, the whole is read from beginning to end, then all the way through again until the entire poem is learned. In such a method psychologists have hoped to avoid some of the difficulties encountered in the part method. When such large units are encountered it is urgent to think of the ideas set forth as a whole and not as a set of particulars. Meaningful associations, then, are at a premium and the learner reacts to the meaning of the selection. By reading through the material all the way any particular section is repeated at an efficient interval. No incorrect connections are formed and the material is learned in just the way it is going to be used later.

The Experimental Evidence. The experimental work upon this topic has been complicated by the various types of material used in the experiments and by disagreement upon the meaning of *part* and *whole.* As an illustration of this confusion one experimenter, Warner Brown, submitted evidence favoring the whole method of learning based on the study of 12 pairs of words (an English word paired with a two-syllable nonsense word) by studying them when presented either pair by pair or by reading them through from beginning to end. The former, he thought of as the part method; the latter, as the whole method. Now it is certainly open to question as to whether twelve pairs of words would constitute a whole in the sense that a poem of three pages would. It would more nearly resemble a stanza than a poem as a whole. Here we have the question of deciding upon the number of items to be included in the part. But it must be clearly evident by now that what might under certain conditions be regarded as a *whole* might under others be thought of as a part. Furthermore, older students might differ from younger children because the former may have crystallized a habit of study which might weight the evidence in one or the other direction, making the better method appear the worse. For these reasons the experiments have disagreed in their results.

TABLE IX

WHOLE VS. PIECEMEAL LEARNING OF POETRY
(Pyle and Snyder, 1911)

Number of Lines	*Part Method Time to Learn*	*Whole Method Time to Learn*	*Percentage of Time Saved by Whole Method*
20	16′ 12″	14′ 17″	12
30	27′ 23″	23′ 53″	13
40	38′ 72″	35′ 16″	9
50	49′ 31″	43′ 53″	12
60	81′ 10″	63′ 38″	22
120	168′ 55″	139′ 35″	17
240	431′ 20″	348′ 00″	19

On the one hand, Pyle and Snyder find the whole method more efficient, while Reed finds very little difference between them. The fourth column in Table IX indicates that the whole method is most efficient with any number of lines up to 240. Reed's experiment cited below probably was not controlled as well as the foregoing one since there were so many subjects and they were relatively less well trained. On the other hand, his experiments did provide for individual differences in the use of a large number of subjects, 169 in this part of the experiment.

TABLE X

Whole vs. Part Method
(Material from Freeman. *How Children Learn*)
(Reed, 1924)

Number Sections	*Average Grade*	*Alpha Scale*	*Average Minutes to Learn*
Part 4	79.94		69.75
Whole 4	80.49		68.4
Part 2	78.25	126.4	
Whole 2	77.39	123.39	

The results are not decisive. In the four-section material the whole method led; while in the two-section, the part method led. The author supplements this table with the following:

(a) 30 found the part method superior
(b) 18 found the whole method superior.

In all cases the differences were probably unreliable statistically. Reed's own interpretation is that the most efficient method is an individual matter. An important item in interpreting Reed's experiment is the age of the subjects who were students in college. If these individuals had used in their studying the part method since early youth the inference is that they would now learn more efficiently by means of the part method. While this point remains unproven, it is worthy of consideration.

The experimental results dealing with non-verbal material are clearly in favor of the part method. One student (Pechstein) investigated these two methods of learning with a "pencil maze" as material. This piece of apparatus consists of grooves to be traced out with a pencil. The problem may vary from a very simple pathway with few blind alleys to a most complex arrangement with a considerable number of blind alleys. These mazes, placed behind a screen so that the subjects could not use their eyes in learning, could be divided into four parts and each part learned separately. The result in this experiment came out quite differently from all the others, for the concentrated part method (i. e., when the individual learned each of the divisions at a time) took a decidedly shorter time. This matter of not using vision on which depends the ability to coördinate and integrate many visual experiences might have been the factor which made all the difference, for the coördination and integration of experiences favor the whole method.

The experimental evidence concerning the use of the part or whole method is not conclusive for it is inconsistent. Of the eleven or twelve reported experiments, about four favor the part method and the rest, the whole method. The learning of the maze was clearly more efficiently done by using the part method. From the results of this experiment one might argue that complicated motor habits such as typewriting, handwriting, etc., would be best done by using the part method. As for the learning of history, poetry, geography, and such like, the experiments differ so much among themselves that probably the best procedure for the individual to follow is to find out as soon as possible by the experimental method what is the most efficient method for him. He should certainly, at all times, whether using the whole or the part method, look for broad meanings and connections in the material read.

5. Accepting Uncritically the Words of the Book

Textbook makers probably more than any other type of writers should be extremely careful in the statements they enter in a book, for young people have a habit of accepting uncritically the statements contained therein. In many outlying districts where books are scarce, the text is *the* book. In all cases there is a tendency for young people to accept the reading matter in textbooks as real honest-to-goodness, genuine truth. This bibliolatry unfortunately is not confined to children. Those who believe in one book and in that alone are very apt to become stagnant in their thinking. For these reasons, it is extremely important that textbooks be placed in the proper categories of material correct for the most part, but which even among the best are highly colored with the author's particular mental set. Even scientists, whose minds are reputed to be logic engines, sometimes interpret the same data quite differently. Such differences of opinions among those who are in the habit of critically judging should give us pause. Pupils from grammar grades on should be taught that these differences of opinion exist. They should always be taught to come to any type of book with questions to be answered, with wonderings about the truthfulness of its content. As an aid in this broadening of experience in the field of history, it would be well for students to read accounts of the American Revolution written both by Englishmen and by Americans; of the Civil War written by supposedly unbiased men of the North, and similar ones of the South, and such like. Attitudes of questioning the truthfulness or falsity of statements are of very great value in the long run and should be cultivated in all.

In studying then the advice would be:—"Come to your text with such attitudes as, (a) Does it fit in with my experience? (b) Does it agree with itself in every particular? (c) How does this account differ from others? (d) Which one is right?" Probably in no other way can such accurate knowledge be acquired by an individual in the course of his reading as that of being ever on the alert to discover errors.

6. Reasoning in an Inefficient Manner

Reasoning is a type of learning. The learning phase of it consists in making the new connection whenever an inference is made. It is rarely ever straightforward as is sometimes pictured in books of logic but most frequently involves a great deal of trial and success. Suppose we take the following problem in long division which is to be solved by filling in the spaces with the correct number.

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           . . . .
       ____________
9 . .) 4. . . 4 . 7 I
       . 9. .
       ------
          . 1 . .   II
          4 . . 5
          -------
            2 . 7 .
            . . . 4 III
            -------
                . 0 . IV
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When first looked at it seems impossible to discover with any degree of certainty the numbers which fit into the blank spaces, but on analysis and careful part by part examination certain details begin to appear. A rear attack seems to be the most successful here as in many other instances. One discovers very soon that the figure just above the five (row II) must be 2 because 5 from only 12 leaves 7. This figure is 2, then, which was drawn from the dividend from between the 4 and the 7. In row III, the last quantity in the upper row is 7 which was simply drawn down from the dividend. In row IV the last number then is 3 simply by subtraction. In row III the number to the left of 4 must then be 7 because the number just below is zero. (Thus far very little reasoning has been involved but only the facts which a simple rearousal of our knowledge of long division warrants.) What is the last number in the divisor? By searching we find certain clues. It is some number that when multiplied by one number ends in 5 (II) and by another, 4 (III). Let us see what numbers when multiplied by another number may end in either 5 or 4; 7, 9, 1, and 3 will all do the work. But which one of these fits the other conditions? Nine must be multiplied by 6 to end in 4 but the number from which this product is to be subtracted begins with a 2 (III). It couldn't be a 9. Could it be 1? No, for 1 must be multiplied by 4 and since the last number in the divisor is 9 and the number in III begins with 2, 1 cannot work. Seven then is the right number because it satisfies the conditions and goes twice. We have thus the first figure in the divisor, 7, and the last one in the quotient, 2; moreover, the next to the last figure in the quotient is 5 for in row II we find that the number ends in 5 and five times 7 is 35. But what is the middle number in the divisor? By observing line III we find it is some number which when multiplied by two and when one is added to it becomes 7. It might be either 3 or 8 and at this stage it is impossible to determine which. Suppose we select 3, then we can proceed to multiply it by 2. This gives us 1874 in the lower part of III and 4685 for the corresponding part of II. If we draw down the 4 from the dividend into upper II and then begin to subtract the 4685 we say 5 from 12 leaves 7, then 9 from 14 leaves 5 and 7 from 11 leaves 4. But the real quantity is 2 which appears in upper III. The middle number is thus not 3 but 8. All the work in the last sentence or two is wrong and must be discarded but, even so, we have made progress for we have determined the divisor. By multiplying by 2 for row III we get 1974 and by 5 for row we get 4935. By subtracting first in row II we get 2077 for upper III and by subtracting 1974 from this we get 103 for row IV. Moreover, the last quantity in upper row II must be 5. It thus appears that only 51 was left over after the first subtraction and two numbers had to be drawn down before the divisor would go, thus showing that the second number in the quotient is 0. But we aren't quite through yet for we have six spaces yet to fill. But we have some clues, the first 4 in the dividend and the 9 under it to the right. What numbers will when multiplied by a 9 preceded by an 8 give the first mentioned 9? A 5 or a 4 will turn the trick. Suppose we try 4. This gives 3948 which when subtracting like this, 8 from 9 leaves 1, 4 from 9 leaves 5, and 9 from 10 leaves 1. But there is no 1 and the work is wrong. Five is the number. Multiplying we get 4935 which gives us in subtracting 5 from 6, 3 from 8, i. e., to get 5 in upper II, and 9 from 9. The complete dividend then is 4986427 and the complete quotient is 5052 and the remainder is 103. The answer is correct because in every instance it checks and fulfills all the conditions. Moreover, no other procedure fits.

A careful survey of the details of the solution of this problem may give us high instruction about the reasoning process itself. In the first place there is almost always some sort of problem which our ordinary habits and innate traits are unable to solve. A mere problem in long division would have depended very largely upon memory, but here we have something new, a challenge, a sort of puzzle to which many of us are attracted. The newness of it confuses us somewhat, throws us into a state of doubt, of wonder whether there is some catch about it, and of whether it can be really solved or not. Second, if progress is made there is a careful analysis of the situation. In this case an attempt is made to see if any of the blanks can be filled in immediately, an attempt to break up the problem into simpler parts. Third, following this, some simple phase of the problem may appear familiar and solvable at once. This gives an attitude of confidence which causes one to strike out more boldly. Moreover, the knowledge already gained is marshaled upon the problem and a careful study is made to see whether or not it fits. Fourth, with the bringing to bear of old knowledge upon the new situation much of it doesn't fit and must be discarded. Parts of it seem to fit and may be tried out only to find that on actual trial it will not work (trial of 3, 9, and 1 in last number in the divisor). Some of it does work and is adopted, thus furnishing a vantage point from which other relations are seen, other facts discovered. Fifth, a solution is arrived at which checks up with all the available facts in the case. And a feeling of satisfaction passes over the individual. If the problem is solved and success achieved one goes away with an increased feeling of confidence to solve other problems. Or indeed the solution of one problem to the bright person may merely raise twenty more, so that the brightest carry around with them hundreds of questions the solution of which is always hoped for.

Reasoning, then, is just as truly learning as reading or writing is. There is one important difference. The problem is always new and complex, usually involving many factors in its solution, and thus requires of humans at least the bringing to bear of knowledge gained on other occasions upon this problem and even the projecting into the future of both present condition and knowledge gained in the past. It is a type of trial and error learning in the numerous trials and errors used in attempting the solution and in the perception of relation between facts heretofore unperceived. This perception of new relations is indeed the very essence of learning.

The student might pause to ask here, do you mean to tell me that men like Edison, Ericsson, Darwin, great inventors and discoverers, go through such a tortuous route when they solve a problem? Indeed aren't you wrong in this, for surely these men think straight to the goal? It would seem so, but it isn't. Edison confesses that his corporation made nearly 3000 trials before they discovered the bamboo filament for the electric light globe, Ericsson, the inventor of the Monitor, had a whole shelffull of discarded inventions. On one occasion Ericsson found his company disputed in a house he had bought by an army of rats. He felt it obligatory to get rid of them by some mechanical invention of his own. He thus built a rattrap so large that it took several men working for days to complete it. When completed it occupied half the basement of the house. He then baited it with half a cheese. But the rats were wiser than he knew, for not a one would go near it and it proved a splendid place to keep the cheese in safety. He was forced to conclude that "these little beasts have brains altogether too big for their heads." [1] Darwin had his "fool" experiments, those which he hardly hoped would be of value but by which some discovery might be made. He even hired his nephew to play his bassoon before a plant in the hope that music might have some effect on the growing plant. Geniuses, therefore, seem to have a greater fertility of imagination, to be able more successfully to bring to bear upon a problem their accumulated experiences, to perceive more quickly more subtle relations, and to be more wise in recognizing the facts which give the solution. It is possible also that they are made more happy in gaining the solution and thus attack new problems more eagerly.

Practical Implications for Study

The solution of new problems depends upon a careful analysis of the situation, upon the bringing to bear of material already learned upon the different phases of the problem; upon the selection and adopting of these facts to the new situations presented; and finally, upon the making of an inference. In the proper study of new problems the student needs to have at his command a workable body of facts which permit of some adaptation. Unless he has learned his previous lessons in such a manner that the meaning was attained he cannot possibly apply them to the present case. Facts, of course, he needs to reason with, but nascent, understood, digested facts. Second, he needs help in the analysis of new situations. In geometry originals, for example, there should be built up a technique for their solution. It is possible that the teacher has built up for himself a workable method for attacking new problems. This should be demonstrated to the pupils. Furthermore, the pupil could well afford to try a few new problems under the teacher's guiding eye and skillfully directed questions. If the new problem consisted in working up an original theme, definite instructions concerning places to find materials and some possible solutions could be suggested. The more mature student might gain help by asking himself such questions as (1) How can this problem be analyzed into its simplest elements? (2) What are the facts that bear upon this problem? (3) How have others attacked similar problems? (4) Where is a good place to find material upon it? He might go over each simple phase part by part consciously bringing up all past experiences related to that point and trying them out systematically. Nothing will ever take the place of native capacity in reasoning, but careful planning may produce far more solutions to problems than we even hoped for.

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[1] Taussig, *Inventors and Money Makers.* Quotes Church. *Life of Ericsson*, Vol. II, p. 306.

7. Working at a Low Level Physically and Mentally

Good physical condition is of the greatest importance for study. Fairly healthy individuals are more prone to neglect this phase of life than those who are definitely sickly. Hundreds of little ailments and dissipations prevent the human organism from being 100 per cent efficient.

Insufficient Sleep. Sleep is one of the necessities of life as truly as food is. Indeed in some experiments with young pups one group was prevented from eating while another group was prevented from sleeping (Manaceine). In a post-mortem examination of the neurones of each group it seemed clear that the neurones of those kept from sleep were in a more advanced stage of disintegration than those kept from eating. Experiments on humans have had varied outcomes. Some experimenters report an increased ability to work, and others, a decreased ability. One subject (Patrick and Gilbert) after 40 hours of being awake found it difficult to stay awake. He would drop off to sleep while standing up talking. Furthermore, both he and another subject found that the time for doing work was lengthened to four or five times the ordinary amount. Recovery from the fatigue engendered by not sleeping was quite rapid, i. e., much less sleep was required for complete recuperation than was actually lost.

Sleep then is a biological and psychological necessity and those who suffer from a lack of it either voluntarily or because they can't go to sleep are running grave dangers of physical and mental exhaustion. Growing children require from 9–10 hours of sleep; high school boys and girls from 8–9 hours, college students at least 8 hours. Pupils and students frequently come to class in a very sleepy condition. Even if they are able to keep their eyes open, their sense is shut. Whatever else you may call this condition, it is not efficient. Five stodgy, sleepy hours of study are not as valuable as two wide-awake, alert ones.

Fatigue. The human organism like an automobile uses up its gas and oil and must stop for repairs. Muscular fatigue and neural fatigue have been studied separately. If the large muscle (the gastrocnemius) in a frog's leg is carefully removed together with the long nerve (the sciatic) which supplies the muscle with stimulation and if both of these are carefully preserved, we are prepared to study the effect of activity of the muscle when electrically stimulated.

Let "E," Fig. 26, be the sciatic nerve entering the gastrocnemius muscle at "B." Suppose it is stimulated with an alternating electrical current. The stimulus is conducted along the nerve and stimulates the muscle. As it contracts, the lever "C" attached to it scratches a trace upon a revolv-

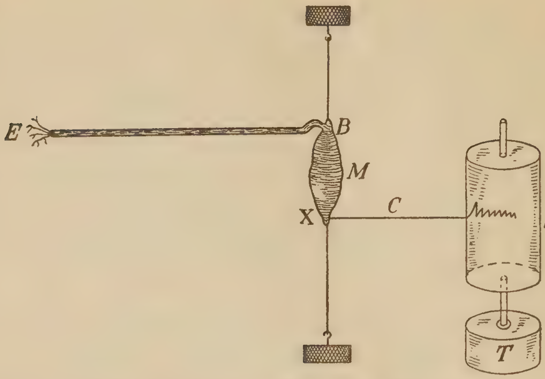

FIG. 26.—Schematic diagram of Method of Recording the Action of a Muscle. E is nerve; M, muscle attached to holder at B; S a kymograph drum which revolves by clockwork in T. Drum has smoked paper covering which registers trace of lever C which is attached to muscle at X.

ing drum "S" which is covered with smoked paper. It is possible to set the trace on the paper thus giving us a permanent record.

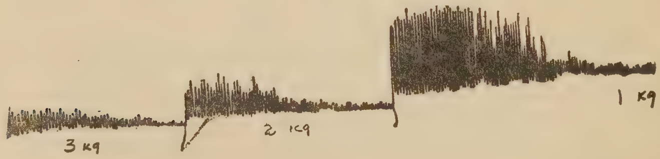

FIG. 27.—Ergograph record of the fatigue of the muscle of the middle finger. The flattening out of the record indicates fatigue. The finger lifted at first a weight of 3 kilograms (about 6.6 pounds). You will note that this weight was not lifted very high. This weight was reduced to 2 kilograms, then to 1. The changes are clearly indicated by the heights of the lines. Records in all cases made on a kymograph (see Figure 26). The weights were raised at a rate of one per second.

Figure 27 although not the record of such a muscle as we have been describing resembles very closely such an one. If when the muscle is thoroughly fatigued it is washed with a saline solution, the collected fatigue products (carbon dioxide, lactic acid, and acid potassium phosphate) are washed out, the reacting begins again though not so vigorously as in the first instance and fatigues more quickly. Furthermore, it is possible to study a single group of human muscles in coördination and integration with the rest. This is done by means of an ergograph which consists essentially of a string fastened to the middle finger at one end and to a weight at the other. This string works over a pulley. At some point on the string a lever is attached which scratches a smoked drum as the weight is lifted. The height of the record is proportional to the strength of the pull. Such a record is Figure 27. It will be noted from the figure that the muscle although attached to all the rest fatigues very quickly.

Finally, the body as a whole may become fatigued to the point when it becomes dangerous.

Signs of too great fatigue

(a) Wandering of attention.

(b) Failure to form associations quickly.

(c) Worrying overly much about matters of little consequence.

(d) Being irritated at slight annoyances and possibly flying into rage.

(e) Pursuing one idea day in and day out, a sort of monomania.

(f) There may occur in extreme cases inability to control the finer motor coördinations. Mistakes are made, objects are dropped, knives slip, fingers are cut.

Neural fatigue does not seem to appear so quickly as muscular fatigue. If into the nerve trunk (Figure 26) there is introduced a drug (curare) near B which causes a blocking of the passage of the stimulation and then if the nerve is stimulated by an alternating current for eight consecutive hours at which time the effect of the curare disappears, then the muscle will begin to contract in the usual way. This shows that the nerve trunk is very difficult indeed to fatigue. Hodge's experiments with rested and weary swallows and with rested and weary bees, and other experiments have seemed to demonstrate that the substance of the nerve cells is used up by work of every sort, that there is a demonstrable difference in size, shape, and content between rested nerve cells and fatigued ones.[1]

Attempts have been made in some instances to discover tasks which depend almost wholly upon the central nervous system for their solution. Experiments have been made in mental multiplication of four-place numbers (Arai) for eleven hours, and for four hours (Painter) beginning at eleven P. M. after a hard day's program of work. In the former case it was possible at the end of eleven hours' work to multiply one four-place number by another provided more time was allowed. In the case of the latter, work could not be continued after three A. M. Furthermore there is some evidence that whenever a stimulus crosses a synapse there is a certain amount of fatigue. All told it would seem that if the time is properly distributed there is little occasion for worrying about mental fatigue in ten hours of work.

Other types of conditions which cause healthy individuals to work at a low level.

a. Colds unattended to.

b. Insufficient regularity of physical habits.

c. Lack of proper balance in meals, producing poor digestion.

d. Many minor ailments which distract attention from the work at hand.

e. Worrying about ailments of various kinds.

These and many other bodily ailments prevent us from living and studying at 100 per cent efficiency.

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[1] See Book, *Learning How to Study and Work*, pp. 47–48.

Summary of Suggestions on How to Study

1. Use the recitation method in learning since it causes you to react more strenuously; to discover errors; and to check up learning. A corollary to this principle would be to verify all facts whenever possible.

2. Distribute your time over as long a period as possible, for to form connections, time is of great importance.

3. Use the whole method for at least the first two or three repetitions. Then concentrate on the hard parts. Discover by experiment whether you are more efficient when using the part or the whole method.

4. Plan out your work; then see to it that the plan is carried through. Planning gives meaning to work.

5. Challenge the statements of books by seeking exceptions to any rules. Ask such questions as, Does it fit in with my experience?

6. In solving a new problem analyze it carefully, then systematically and painstakingly bring to bear on it the results of your experience. Remember that sometimes a rear attack is as good as a frontal one and, at times, more prolific of results.

7. Finally see to it that you keep in good physical condition by planning out regular hours for work and play, for sleep and by calling upon a physician at the first symptoms of any disease.

QUESTIONS AND EXERCISES

1. Discuss the advantages of the recitation method in study. With what sort of material is the method most successful? Why? With immediate or delayed recall?
2. Compare the advantages and disadvantages of the distributed versus the concentrated method of study. Just what is meant by cramming?

3. Keep a careful record of the way you spend your time for one week. Keep carefully the following record and conclude as to your own distribution of time.

	TIME DEVOTED TO EACH ITEM PER DAY						
	Mon.	*Tues.*	*Wed.*	*Thur.*	*Fri.*	*Sat.*	*Sun.*
Sleep							
Study							
Other work							
Church							
Meals							
Athletics							
Other recreation							
Total profitable time							
Total unprofitable time							

4. Plan out an hourly schedule for three days and see to it that it is carried out. Planning without execution is useless.
5. Choose two poems of about equal length, difficulty, and familiarity. (1) Learn one stanza by stanza, learning the first stanza first and then adding the new ones to it until the whole is learned. Keep a careful record of the time. (2) Take the second poem, read it all the way through without stopping. Read it through again and again until you can say it perfectly. Record the time. Which method used up the most time?
6. Study your next lesson by using the recitation method, i. e., when you have read three or four pages stop and recall what you have read. If very little is retained use smaller units for purpose of recall. Keep a careful record of the time and of your knowledge of the chapter.

7. Cite three questions that you should ask about your history lesson before you read it, about your Latin lesson, your mathematics lesson. Why is it so easy to believe what is written in a book?
8. Summarize the main features of the reasoning process. What differences are there between the logical and psychological treatment of reasoning?
9. Solve the following problem. Keep a careful record of your various attacks and your failures upon the problem, such as was done in the problem on page 177.

   A three-inch cube is painted on all sides. It is then cut up into one-inch cubes. (a) How many cubes would be painted on three sides? (b) How many on two sides? (c) How many on one side? (d) How many on no sides?
10. Keep a record of your daily meals for three days. Are your meals well balanced? Do you eat meat more than once a day? Do you eat something green each day? Do you feel soggy and sleepy after the meal? Why? Did you eat an apple or orange each day?
11. Do you have headaches? Do your eyes run water? Do they smart? Do your colds hang on for three or four weeks? When is a physician most helpful?
12. Try out all the principles laid down in this chapter for one week. Report, in writing, your opinion about their value in your own case. Give the principles a square deal.

REFERENCES

Book, W. F. *Learning How to Study and Work Effectively*, 1926.
Crawford, Claude C. *Methods of Study*, 1926.
Earhart, Lida B. *Teaching Children to Study*, 1909.
Gates, A. I. *Psychology for Students of Education*, pp. 289–293, 1923.
Headley, Leal A. *How to Study in College*, 1926.
Kitson, H. D. *How to Use Your Mind*, 1916.
McMurry, F. M. *How to Study and Teaching How to Study*, 1909.
Miller, H. L. *Directing Study*, 1922.

Starch, Daniel. *Educational Psychology*, Chapter XII, 1920.
Whipple, G. M. *How to Study Effectively*, 1916.
Woodworth, R. S. *Psychology*, Chapter XIV, 1921.

Larguier des Bancels, J. "Sur les Méthodes de Memorisation," *Année Psychol.*, 1902, Vol. VIII, p. 185 and 1904, Vol. X, p. 131.

Brown, Warner. "Whole and Part Method in Learning," *Journal of Educational Psychology*, 1924, Vol. XV, pp. 229–233.

Ebert, Ernest, and Meumann, E. "Über einige Grundfragen der Psychologie des Übungs-phänomene im Bereiche des Gedächtnisses," *U. A. W. Archiv f. d. ges. Psychol.*, 1904, Vol. IV, pp. 1–232.

Ephrussi, P. "Experimentelle Beiträge zur Lehre vom Gedächtniss," *Zeitschrift f. Psychol.*, 1904, Vol. XXXVI, pp. 56–103; 161–224.

Gates, A. I. "Recitation as a Factor in Memorizing," *School and Society*, 1917, Vol. VI, pp. 743–749.

Lakenan, M. E. "The Whole and Part Methods of Memorizing Poetry and Prose," *Journal of Educational Psychology*, 1913, Vol. IV, pp. 189–198.

Meumann, G. "Exp. Beitr. z. Lehre V. D. Oekonomie u. Technik d. Lernens," *Dissertation Göttingen*, pp. 1–60, 1906.

Molhman, D. K., and Monroe, W. S. "Training in the Technique of Study," *Univ. of Illinois Bulletin*, 1924.

Pechstein, L. A. "Whole versus Part Method in Motor Learning, A Comparative Study," *Psychological Review*, Mon. Supplement, 1917, Vol. XXIII, No. 2, pp. 59ff.

Pechstein, L. A. "Massed versus Distributed Effort in Learning," *Journal of Educational Psychology*, 1921, Vol. XII, pp. 92–97.

Pentschew, Christo. "Untersuchungen zur Oekonomie und Technik des Lernens," *Arch. f. d. ges. Psychol.*, 1903, Vol. I, pp. 417–526.

Pieron, Henri. "Recherches expérimentales sur les phénomènes de mémoire," *Année Psychologique*, 1913.

Pyle, W. H., and Snyder, J. C. "The Most Economical Unit for Committing to Memory," *Journal of Educational Psychology*, 1911, Vol. II, pp. 133–142.

Reed, H. B. "A Repetition of Ebert and Meumann's Practice Experiment on Memory," *Journal of Experimental Psychology*, 1917, Vol. II, pp. 315–346.

Reed, H. B. "Distributed Practice in Addition," *Journal of Educational Psychology*, 1924, Vol. XV, pp. 248–249.

Reed, H. B. "Part and Whole Methods of Learning," *Journal of Educational Psychology*, 1924, Vol. XV, pp. 107–115.

Steffens, L. "Untersuchungen zur Oekonomie und Technik des Lernens," *Zeitschrift f. Psychol.*, 1900, Vol. XXII, pp. 321–382.

Taussig, F. W. *Inventors and Money Makers*, 1915.

CHAPTER VII

TRANSFER OF TRAINING

Transfer of training and mental discipline or formal discipline closely resemble each other. They differ in this respect. Mental discipline may be said to accrue from studying certain subjects in a more general way, thereby developing mind which can meet many of life's situations. By "meeting life's situations" is meant that many experiences acquired in the school situation *transfer* to life's situations. For this reason, transfer of training and formal discipline are frequently treated together.

The mind is a unitary whole, made up of functions more or less closely related. Some are so closely related that the improvement of one mental trait affects perceptibly and immediately the action of another. Others are so distant in their kinship that change in one produces no measurable change in another. While some others are antagonistic—i. e., the improvement of one function causes a decrease in another.

Now since the brain and particularly the cortex exert a centralizing influence upon all mental functions the question arises as to the degree of relations among the mental processes. Put more specifically, what effect does the improvement of one function have upon the improvement of another? The school is particularly interested in the solution of this problem. The amount of material to be learned is so great that children can master only a small part of it. It becomes a question of selecting the material in such a way that it will be common to the largest number of life experiences, and of teaching it so as to develop the more general types of experience; for from each subject it is possible to obtain methods of attack, habits of study, and ideals of accuracy. How can we be certain that these will be secured?

Such problems as those given below contain the essence of the question of the transfer of training. To what extent does the knowledge gained in one subject transfer to another subject, to the activities of the school ground—to life itself? More particularly, to what extent does a course in Latin aid one, (a) in defining English words of Latin origin, (b) in defining words of Anglo-Saxon origin, (c) in defining words of Greek origin, (d) in knowledge of English grammar, (e) in ability to spell a word derived from Latin? But let us consider some of the still more general values. To what extent is the pupil's method of study improved, his attitude towards school and towards life changed? Does he now observe the cleanliness of his meat market more accurately because he has learned the endings of the five declensions or distinguished between closely allied forms of verbs? Is he better able to follow through a political argument by nicely discriminating from among lists of party statements those which are sound and fitting because he has selected from a half dozen meanings in a vocabulary that one which fits the general trend of the sentence, paragraph, and oration? In brief, students of education are no longer satisfied with a simple statement that transfer takes place. They want to know the amount of transfer and its direction.

The discussion of this question shall occupy us for the next two chapters. The present chapter considers the more theoretical and general aspects of the problem; the next one will treat of the more concrete problem of the transfer value of the school subjects as they appear under school conditions.

Methods of Discussion

In the past, two methods of arriving at conclusions in the field of transfer have appeared. One of these, the method of opinion, had been most broadly used, up to a few years ago. It consists briefly of introspective accounts or beliefs in the transfer value of certain subjects. Thus one spoke of algebra as shaping the mind; of arithmetic as developing habits of mental attention, of absolute accuracy; of Latin as disciplining the faculties; and of foreign language as improving the command of one's own. In spite of the psychologically crude methods of statement, we find that in nearly all of these statements there are some elements of truth. Modern experimentation has separated the truth from the falsehood in these opinions. It has defined and made quantitative statements which before were without limit and qualitative.

The Experimental Approach. Students of Education and Psychology had already realized that the claims of the disciplinarians—that is, of those who believed in the transfer of training and consequently in the inclusion in the curriculum of the more formal type of material which should be taught by a more severe discipline—were not justified. In their attack on the classical education of the day Spencer and Huxley had stood up for a more practical type of education. Huxley had even used the ammunition of the classicists—the disciplinary argument—in proving that the dry bones of paleontology could be arranged in a series of problems—which would "beat the recent famous production of the headmasters out of the field in all these excellencies." But even these critics could not express their ideas precisely until the advent of the scientific method.

Scientific studies in the transfer of training of the best type have followed the line of Experimental Method and of Parallel Groups described in Chapter I. Ordinarily there are two end tests which all subjects take and a training series which only a part take. The following table will make that clear.

TABLE XI

Skeleton of Transfer Experiment

	Test Series	*Practice Series*	*Test Series*
Group I (Practiced)	Takes	Takes	Takes
Group II (Control)	Takes		Takes

Groups I and II are made equal in the best manner by pairing individuals of equal capacity as determined by preliminary tests in the "test series." Not only are they made approximately equal pair by pair but the total scores of the two groups must also be equivalent. No inferences worth mentioning concerning transfer can be drawn unless the groups are equivalent. Then Group I takes the practice for several periods. Many of the experiments in transfer have had such short practice periods that there could not be sufficient improvement to transfer to any very large extent. You will note that Group II (the control group) does not take the practice. It goes along doing the ordinary things in the usual way. After a sufficient time has elapsed both groups are tested again. Most probably each will gain. The difference in the gain in the test series between the Practice Group and the Control Group constitutes the amount of Transfer.

There are, too, certain criteria by which we can judge as to whether or not a transfer study has been adequately performed.

(1) Are there a sufficient number of cases to make the findings reliable?

(2) Were the conditions of the experiment properly controlled? Here, the matter of differing teachers, time of year, etc., appear.

(3) Were the groups equivalent to begin with?

(4) Was one of these groups a control group?

(5) Was the percentage of gain in the practice series expressed?

(6) Was the difference in gain between the Practiced Group and the Control Group shown to be statistically reliable? While it is difficult to find a transfer experiment which satisfies all these criteria, Sleight's experiment[1] on the transfer effect of memorizing one sort of data upon a similar sort comes as nearly as any to satisfying all these criteria.

Two classes of women students of the average age of 18–19 acted as subjects in that part of the series of experiments quoted here. The students were divided into four groups of equal ability. The test series given to all consisted of six different types of material for memorizing:

(1) Tests of dates with their appropriate events,

(2) Tests of nonsense syllables,

(3) Poetry,

(4) Prose (verbatim),

(5) Prose substance, reading twice a short prose extract, after which the substance was reproduced in writing.

(6) Letters (nine consonants in haphazard order at one dictation).

The Practice Series. For twelve consecutive days students were trained for one-half hour each in (1) learning poetry, "poetry practiced"; (2) learning tables—"tables practiced"; and (3) learning prose substance, "prose substance practiced." Each of the equivalent groups except the control was practiced in one of these three types of material.

In Table XII the practiced groups are compared with the unpracticed. The table is to be interpreted as follows: The effect of practice in memorizing poetry upon the ability to memorize dates was greater than in the case of individuals who had not had such practice, i. e., the gain in the Practice

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[1] Sleight, W. G. "Memory and Formal Training," *British Journal of Psychology*, 1911, Vol. 4, pp. 386–487.

Group minus the gain in the Control Group is represented by 32, and similarly for the rest.

TABLE XII

The Influence of Memorizing one Type of Material upon Memorizing Material of Another Type

(Sleight, 1911

			Groups 2, 3, and 4 Compared with Group 1	*Probable Error*
Dates	Group 2	Poetry practiced	32	25
	" 3	Tables "	(59)	24
	" 4	Prose Subst. practiced	−6	24
Nonsense Syllables	Group 2	Poetry practiced	(33)	13
	" 3	Tables "	9	13
	" 4	Prose Subst. practiced	−62	13
Poetry	Group 2	Poetry practiced	(33)	16
	" 3	Tables "	−27	16
	" 4	Prose Subst. practiced	−7	16
Prose (Literal)	Group 2	Poetry practiced	9	21
	" 3	Tables "	−36	20
	" 4	Prose Subst. practiced	−17	19
Prose (Substance)	Group 2	Poetry practiced	−7	33
	" 3	Tables "	49	32
	" 4	Prose Subst. practiced	52	31
Letters	Group 2	Poetry practiced	−24	13
	" 3	Tables "	−3	13
	" 4	Prose Subst. practiced	(−27)	13

The numbers in parenthesis (Table XII) are from two to three times the size of their probable errors and therefore of greater reliability than the rest, but even these are of doubtful reliability in most cases. "Doubtful," because to be certainly reliable the difference between the two groups should be at least three and preferably four times the size of its probable error. If the difference is four times the size of its probable error it is a true difference and would certainly appear were the experiment repeated with a different sampling of subjects. By using this standard of judgment we have only one case of a true difference and that is −62 which is more than four times the size of 13, its probable error. There seems to be no doubt that practice in learning to get the ideas from reading, works harmfully on the ability to memorize verbatim nonsense syllables. Thinking of meanings consequently transfers negatively to thinking of exact sounds. Of transfer in the positive direction, learning poetry affects in a positive direction the learning of nonsense syllables and the learning of further poetry; and secondly, learning tables affects similarly the learning of dates.

By a further study of Table XII it is found that in 10 out of 18 cases the Control Group did better on the test series than the Practiced Group. This is represented by the negative scores. In some cases there was actual retrogression on the part of the Practiced Group when they took the test series the second time. On the other hand, in 8 cases there was a positive transfer. If we assume that all the points are equal and then add up the gains and subtract the losses we find 60 points on the side of improvement. This would show that there is some transfer on the average but the average is not what we want.

What is wanted is a knowledge of the specific amount and direction of the transfer. In brief, what is the effect of practice in memorizing poetry on the six abilities included in the test series? We shall see that memorizing poetry aided in learning dates and their events, nonsense syllables, and other poetry. The transfer was clear in the direction of similarity of method, for each function required an exact reproduction of the material learned. On prose both literal and substance and in learning letters there was no reliable transfer effect. We should have expected transfer in the case of letters. It may be that poetry, nonsense syllables, and dates require the comprehension of three or four smaller units in one large unit, while memorizing letters may require attention to each one in turn. Memorizing tables of population, import and export tables; foreign and English coinage systems, positively aids in learning dates and their events and prose substance. In the other cases the transfer effect is slight or negative. Memorizing the meaning of prose aids positively only in learning further prose substance.

The general conclusions of the author when summarizing the details both of this experiment and of another longer and more elaborate than the one here reported were:

"1. There appears to be no general memory improvement as the result of practice, nor any evidence for the hypothesis of the general memory function.

"2. There would seem instead to be a very large number of related and unrelated memory functions, of a more or less complex kind.

"3. The relation which produces transference is not necessarily (a) an external relation perceivable by an external observer, nor (b) a relation perceivable by the learner, but (c) a common factor, of which the individual mind makes use, consciously or unconsciously. The individual's awareness of the usable common element may produce an earlier and greater effect.

"4. The existence of common elements in two memorizing processes, though necessary, is not sufficient. To involve 'transfer' the common elements must be separable from the complexes in which they occur. This process of disintegration usually renders the improvement brought about in the related subject smaller than that reached in the practiced subject.

"5. The factors which chiefly make for the transfer of memorizing power are similarities of a fundamental nature, such as specific forms of attention, imagery, rhythm; in short, similarities of procedure. These will, within limits, vary for the individual mind."

This experiment quoted in such detail had sufficient numbers of cases to make the results fairly reliable, the conditions were properly controlled, the groups were equivalent, and one of the groups was a control group. In the experiment quoted the percentage of gain in the practice series was omitted but the results were listed for their reliability. The disadvantage of not publishing the gain in the practice series is immediately apparent, for we expect the individual who gained most in practice to gain most in transfer and vice versa. In many experiments subjects who have gained little or not at all in the practice series made demonstrable gains in the test series. This failure to report improvement in the practice series in Sleight's case is not a serious one because this writer did report such improvement in another study and must have had it in mind in this one. Transfer experiments have been conducted on a variety of mental processes. There will be given typical experiments in each field and a summary of the results.

Transfer in Sensorimotor and Perceptual Processes

One of the best studies we have as well as one of the most influential is Thorndike and Woodworth's study of the effect of the training in several sorts of perceptual material upon functions similar in some respects but with some essential differences. One of the sets of material was made up of areas of varying sizes, training in which might have a transfer effect upon areas of different sizes or shapes. The effect of training in discriminating differences in areas of 10–100 sq. cm. upon areas of the same size but differing in shape was 44 per cent as much gain as had appeared in the original areas. When the size was changed to 140–300 sq. cm. the improvement was 30 per cent as great. When both size and shape were changed the improvement was 52 per cent as great as in the 10–100 sq. cm. Similar results appeared when the effects of practice in the discrimination of weights of 40–120 grams were transferred to the discrimination of weights from 120 to 1800 grams, i. e., the improvement in the second case was only 39 per cent as much as in the first. Subjects practiced in marking out words containing e and s improved in marking out words containing i and t, s and p, c and a, e and r, a and u, l and o, misspelled words and A's, in *speed* 39 per cent as much as in the first case and in *accuracy* 25 per cent as much. The authors attribute the transfer effect to ideas of method and habits of procedure. They came to a conclusion which has affected profoundly the attitude towards the transfer of training. They concluded that training transfers when there are identical elements. "The general consideration of the cases of retention or of loss of practice effect seems to make it likely that spread of practice occurs only where identical elements are concerned in the influencing and influenced functions." The results of this experiment and of other similar ones lead to an almost complete abandonment of the theory of transfer by a goodly number of psychologists. A more careful reading will convince anyone that this extreme view is not warranted by the results of the experiment, for the smallest amount of transfer in the test series was one-fourth as much as the students gained in their practice, a rather substantial amount.

It will be noted that this principle of identical elements offers a possible answer to the question asked in the beginning of this chapter relating to the amount and direction of transfer. If we are willing to accept this principle, then the greater the number of identities there are between two functions the greater will be the amount of transfer, the fewer the number of identities the smaller the amount of transfer. If addition is used exactly in multiplication as it was previously learned then the transfer will be considerable. If physics uses the equation in exactly the same way that it was learned in algebra there will be a large amount of transfer. But if the algebra teacher has used with her pupils a sufficient variety of equations so that the general elements common to all solutions of equations are learned, then the work in algebra will transfer to physics whether or not the equations used in it and in algebra have been similar. This principle of identical elements is so important that it will need further discussion after a few more experiments have been reviewed.

Summaries of Other Experiments

Coover and Angell found transfer effect from 17 days' training in discrimination of sound intensities to ability to discriminate shades of gray, and that card sorting affected typewriting favorably. Their results are not conclusive. C. J. C. Bennett found no transfer of the practice by blindfolded subjects in setting movable apparatus at standard distances to the comparing of various lengths with a standard length. Transfer did occur, however, from training in discriminating between blues of different degrees of saturation to the discrimination of mixtures of (a) red and white, (b) yellow and green, (c) orange and black. There was no transfer from visual to motor practice. There was, finally, a gain in motor speed and accuracy due directly to training in typewriting and shorthand.

Scholckow and Judd investigated the effect of instruction in the principle of refraction of light upon the abilities of boys in the fifth and sixth grades to throw darts at targets placed under water. They divided the boys into two groups. One group was carefully instructed in the scientific principles of the refraction of light when it passed through water. The other was left uninstructed. At first both groups were set at the task of throwing darts at targets located under twelve inches of water. Both groups seemed to do equally well, i. e., there was no measurable improvement which might be attributed to the instruction. Thus far the experiment demonstrated that no theory could take the place of real experience with actual conditions. The depth of the water was then changed to four inches and both groups began work the second time. Then and only then was the result of instruction made apparent, for the instructed group profited by their experience with targets in twelve inches of water and soon mastered the four-inch-deep situation while the other group using the same procedure as in the first case had to learn anew the facts about the effect of water on the passage of light. It thus seems clear that theoretical verbal explanations facilitate habit formation when they go along with experience. The writers interpreted the transfer as being due to the effect of the generalized experience upon the instructed group.

Several other experiments bear out the general results quoted in the previous paragraph. There is both positive and negative effect upon the ability to complete lines, parts of which are exposed and parts of which are not, by more complete training in completing one line with full visual experience. There seems to be improvement in observing more accurately geometrical figures when a subject is informed of the results of his work. Canceling letters of one sort transfers slightly to marking out letters of another sort. Training has little effect on increasing the scope of attention as measured on the tachistoscope. And so the story runs. In general, there is transfer from learning some perceptual experiences to other perceptual experiences. The effect may be positive or negative depending upon the habits involved. The functions may be mutually contradictory so that an increase in one produces a decrease in the other.

TRANSFER IN THE FIELD OF MEMORIES

The transfer in training from one type of memorizing to another has interested psychologists from the very beginning of their work in this subject. Will not memorizing in one field train the memory, they said, so that all fields will be affected? The very first experiment to determine the transfer of effect of a function was conducted by William James in the field of memory. He and his students kept a careful record of the time it took them to memorize similar passages after they had practiced memorizing some other type of material. He himself used Victor Hugo's *Satyr* as a test and practiced about 20 minutes daily for 38 days in learning the first book of *Paradise Lost*. Before the training, 131 5/6 minutes were consumed in memorizing 158 lines of the *Satyr*, while after the training 151½ minutes were consumed in memorizing the same number of lines. James reports himself as being weary at the second period. James then prevailed upon four other individuals to carry through experiments in memorizing quite similar to his. Their findings were much like the results just cited. James concluded that one does not really improve his memory but only his methods of recording facts. This experiment was low in technique. There were no control groups and one of the subjects was perceptibly fatigued at the time of the second test. Opposite results appear in our next experiment, for Ebert and Meumann's almost classical experiment seemed to show an enormous amount of transfer from one memorized function to another. Here again things suffered terribly from the lack of a control group.

Ebert and Meumann planned a very elaborate experiment to test the possible transfer of learning in many directions. Their test series was very long to take. One writer (Rugg) has estimated that the subjects must have spent nine hours on the test series. The question they raised was, what is the effect of long training on memorizing nonsense syllables (512 repetitions of 32 series of nonsense syllables with 12 syllables in each series) upon memorizing letters, numbers, visual forms, nonsense syllables, words, German words with Italian equivalents, verse and prose extracts. As the experiment turned out the transfer appeared to be as high as 30–50 per cent in reproducing numbers, letters, etc., and high in visual forms. In verse there was little gain but there was improvement in prose. These authors attributed the results to a sort of psychological interaction of allied memory functions. The inordinate amount of transfer obtained in this experiment was undoubtedly due to practice in the test series. Think of it, nine hours long! There being no Control Group, improvement in the test series was taken here as transfer effect when it was partly due to practice in memorizing these particular functions. Dearborn had some subjects take the test series without the practice series with the result that subjects with no practice series at all made enormous improvement in the test series. Dearborn has shown, for example, that when the test series in memorizing letters was repeated there was an improvement of 29 per cent. Ebert and Meumann had found 52 per cent, all of which they had attributed to the effect of transfer. Thus the 50 or 60 per cent of transfer found by these investigators on the average turn out to be a little more than 20 per cent, a moderate transfer and one much like that found in other studies.

The work of Sleight cited as an illustration of a typical experiment in transfer falls normally under this present subject of the transfer of memorizing. In this study, you will remember, it turned out that the greatest transfer was in the direction of functions most similar in their use of mental processes. Memorizing tables had the greatest effect on learning dates, poetry on further poetry and dates, and the memorizing of prose substance affected positively only other prose substance. With this latter there seemed to be a negative transfer effect on learning nonsense syllables. Memory then seems not to be one great function improved by what it practices on but many functions, some closely related, others more distantly. Memorizing a passage for the thought or ideas is not related to memorizing a similar passage word for word. Practice in the first may even injure the second.

Fracker's experiment on transfer was among the more carefully conceived and executed ones. He was interested in the direction of transfer and hence used a variety of parts to his test series, viz:—memorizing poetry, order of grays, a different arrangement of four intensities of sound, arrangement of order of four grays, order of four tones on a piano, order and form of 9 geometrical figures, order of 9 2-place numbers, and finally the extent of arm movement. The problem was to discover the transfer effect upon those functions of memorizing the order of tones and holding them in mind for eight seconds of filled time. During the first four of those eight seconds the subject reported the results of a previous learning experiment and during the second part he learned a new order of sounds. For example, a subject would be given four sounds of differing intensity at the rate of one each half second, then a rest period of four seconds would occur. After this rest period he would learn a new arrangement of sound intensities and following this second learning he would report the order of the first four learned. Transfer did take place. The direction was positive in every case except in arm movement. The transfer was greatest to remembering the order of four grays, then came in order nine tones, nine grays, and four tones. For five geometrical figures, nine 2-place numbers, arm movement, and poetry, the transfer effect was less than 4 per cent; for four grays, nine tones, nine grays, and four tones the transfer was 16 per cent. This experiment was one of the first to introduce a control group.

It thus seems clear that the ability to organize facts such as the order of tones for reproduction is transferable. Most probably transfer takes place when a subject is able to use identical elements in new situations. This inability of a subject to use identical elements in new situations may account for the fact that the results did not come out quite so smoothly as one might have hoped, for one subject who made a miserable showing in the practice series with almost no improvement made a big gain in the test series; while another who carried on the practice for 3600 more trials made excellent progress in the practice series but this had no appreciable effect on the test series. The point in the last being, of course, that the more improvement made in one function the greater transfer do we expect to other functions.

We shall conclude the summary of the experiments in this section by quoting from one of Winch's experiments. His experiment differs somewhat from those quoted (except Sleight's) in that it was carried on with school children in the ordinary school situation and in that he went to a great deal of trouble to secure properly balanced groups. His problem was to test the influence of memorizing poetry upon the children's ability to memorize passages from history and geography. His conclusions were that improvement is transferred to material quite dissimilar from the practice series, that is to say, that there was a measurable amount of transfer from memorizing poetry to the memorizing of material from geography and history. In one of the experiments the residual gain (i. e., the difference in favor of the Practice Group over the Control Group) was only 5 per cent which might have been a chance result. This small transfer effect makes his conclusions of doubtful value.

In practically all cases there is evidence of transfer. In the majority of cases the amount the Practiced Group gains in the test series is about one-fifth the amount they gained in the practice series. Frequently this one-fifth is in fact due to the practice in the test series itself. When this specific practice is allowed for, the amount of transfer does not loom very large; furthermore, one must never forget that the functions with which the experimenters have worked and between which transfer has been studied are quite similar. Indeed, they would ordinarily be called by the same name, e. g., the transfer from the memory of the order of sounds to the memory of the order of colors, from the memory of nonsense syllables to the memory of letters, from the facility in memorizing poetry to facility in memorizing geography. And yet one loses, I think, the most important fact if he fails to recognize that transfer does take place. In only a few cases does training in one thing hinder training in another.

Transfer in the Case of Reasoning and Other Associative Processes

It has been amply demonstrated that transfer takes place in the simpler perceptual and memory processes and at least to some extent the amount and direction of that transfer has been indicated. We are just now entering into a discussion of the amount of transfer when the more complicated mental processes are involved. Does reasoning in one field transfer to reasoning in another? Does reasoning in arithmetic transfer to reasoning about the probability of which thief it was who entered our house and to what extent does it?

This question has recently (1922) been experimentally attacked by W. H. Winch. This investigator attempted to discover the effect of reasoning in arithmetic on reasoning of a more general nature. The pupils (58 girls of an average age of 12 years, three months) were divided into two equivalent groups by means of the initial test. One of these groups then was trained ten weeks in special lessons in arithmetic reasoning. Great care was taken to prevent mere juggling with numbers to get the answer and to secure an understanding of the principle involved, while the other group (the Control) took their ordinary lessons under their teacher. Many scientific checks to insure accuracy were employed in this experiment. The pupils did not know that an experiment was in progress, the time element in the solution of the logical problems was eliminated by giving the pupils all the time they wished, and other precautions of a like nature were taken. There are a few chances of error. It appears from the report of the experiment that a different teacher taught the "practiced group" although the writer remarks the "'non-practiced group' took their ordinary time-table lessons under their own teacher—a *capable one*." It will be noted that only twenty pupils of the original 58 took all the tests. This fact makes the results somewhat less reliable.

TABLE XIII

SHOWING, SECTION BY SECTION, THE RESULTS IN LOGICAL REASONING OF THE TWO GROUPS COMPARED
(Winch, 1922)

Marks in Preliminary Logic Tests	*Practiced Group*			*Non-Practiced Group*		
	No. of Girls	*Prelim. Av.*	*Final Av.*	*No. of Girls*	*Prelim. Av.*	*Final Av.*
over 45	3	52.0	64.7	3	51.7	53.3
40–45	5	42.0	48.2	5	40.4	36.4
30–40	7	33.1	51.1	7	32.9	39.6
under 30	5	20.4	39.2	5	21.7	31.4

Note particularly that both those who were weak in the initial tests as well as those who were strong improved under the careful practice in problems. The words of the author may be used in concluding this experiment. "In other words a differential improvement of about 150 per cent in Problematic Arithmetic is accompanied by a differential improvement of about 30 per cent in Logical Reasoning."

The matter of the transfer of neatness has been reported in two investigations which are related to each other. The first one was carried out under the direction of C. R. Squire. "The test consisted simply in insisting on neatness and accuracy in the preparation of arithmetic papers by pupils in the latter half of the third grade." (Bagley, 1911.) Nothing was said about these matters in the rest of the school subjects. Language and spelling papers were compared with arithmetic papers for improvement in neatness and accuracy. It was clear that there had been improvement in 12 pupils out of 13 in neatness and accuracy in arithmetic. "The average gain for the 13 pupils was 3.69 per cent in accuracy, and 4.9 per cent in neatness (reckoning the increase on the markings of the papers which was upon the ordinary scale of 100)." On the contrary, when language and spelling papers were marked by the same individuals it was found that there had been a decrease in both accuracy and neatness in every case save one. It was concluded that there was nothing in the specific training which transferred.

The second experiment was undertaken by W. C. Ruediger to test out one of Bagley's theoretical formulations as to whether or not transfer takes place when the matter is fully conscious and raised to a plane of an ideal. In short, does an ideal of neatness transfer? The experiment was carefully planned. In written work in one school subject great attention was paid to the matter of neatness. It was both insisted upon in the written papers, and talks were made about the advantage of neatness in dress, business, the home and such like. Great effort was made to develop an ideal of neatness although no mention of this neatness was made when the classes in other subjects were in session. Papers were collected from the seventh grades of three different schools. The papers were graded for neatness by three competent teachers and the average of the three used.

TABLE XIV

THE EFFECTS OF IDEALS OF NEATNESS DEVELOPED IN ONE SUBJECT ON OTHER SUBJECTS

(Ruediger, 1908)

Number Subjects	*Geography* 15			*Arithmetic* 15			*Grammar* 15			*History* 15		
	1	2	3	1	2	3	1	2	3	1	2	3
Group I Average	85.3	87.	90.3	84.5	86.3	88.5	83.6	85.5	87.			
No. Subjects	10	10	10	10	10	10				10	10	10
Group III Average	83.8	86.2	86.7	76.	79.2	80.5				85.7	87.3	87.7

1. Grade before neatness was developed.
2. Second grade for neatness at about the middle of the experiment.
3. Third grade for neatness given near the end of the experiment.

Group II is omitted here because there were many irregularities in the original table.

In Group I, ideals of neatness were emphasized in the geography class while in Group III they were in the arithmetic class. By reference to the table it is seen that the greatest gain in neatness occurs in Group I in geography (the class in which neatness was taught) but there was also gain in neatness in the other subjects. In Group III the greatest gain occurred in arithmetic but there was a gain in the other subjects also. The author concludes that ideals do transfer. The evidence from this study is rather thin since the gains were slight, the marks of the papers subjective, and there was no control group.

Ruger attempted to determine the transfer effect of (a) putting puzzles back together once they had been taken apart, and (b) the transfer effect of learning a puzzle in one position upon its solution in another. There seemed to have been considerable effect in "a," one subject practicing taking the puzzle apart 400 times without ever putting it back together or seeing anyone else do so. The average time in seconds for the first five trials in taking the puzzle apart was 46, while putting it together it was only 4.6, one-tenth the former. . . ." There seemed to be transfer from one position to another provided there was "a carefully discriminated idea of the relations of the different positions." To pursue this matter further, one subject practiced 400 times with the puzzle in the four main positions. Each of the positions was practiced until the subject had developed a special technique for handling it in the minimum time. The purpose was to decide whether practice in these four special positions would affect the solution of the puzzle as a whole when attacked in a chance position. There was little gain from special practice in handling the puzzle when placed in a chance position. The average of the first four trials in the first test series was 12.2 seconds. After 400 trials with the four main positions of the puzzle the average of the last 28 trials was 11.6 seconds.

After a very painstaking study of the introspective accounts of the subjects many of whom were trained introspectionists, this author attributes the transfer among other things to (a) ideals of efficiency, (b) high level of attention, (c) good attitudes, i. e., change from self-conscious to problem attitude, (d) conscious control of assumptions, (e) the development of a generalized formula of procedure especially if developed in the first few trials, and (f) experience with other puzzles.

The two experiments of Squire and Ruediger lack many of the essentials of the scientific method. Improvement was not measured objectively in any sense although the average score of three individuals was used. The results were not tested for reliability, there was no control group, etc. The results, however, are consistent: there is always improvement but whether or not the improvement was due to the development of the ideals of neatness has not been certainly determined.

From the simple experiments presented in the (a) perceptual processes, (b) memory processes, and (c) reasoning processes, the general conclusion must be that transfer takes place. Moreover, it seems clear that there has always been some similarity between the two functions wherein transfer was found. Improvement in the perception of words with certain letters transfers to the perception of other words containing different letters, memorizing verse tends to aid in memorizing nonsense syllables, reasoning in arithmetic transfers to reasoning about more practical matters. There has been little if any indication of any transfer to all functions or to even remote ones. Memorizing by rote seems even to hinder memorizing for substance. The question we shall try to answer now is the manner of transfer.

THE MANNER OF TRANSFER

A very large variety of conditions has been set forth by means of which transfer takes place there being almost as many ways as there have been experiments. Identical elements, generalized experience, concepts of method, consciously acquired ideals, more perfect habituation, divesting the problem of nonessential elements, conceptualizing abilities, the sympathetic interaction of allied memory functions, effective use of mental imagery, improvement in technique of learning, improvement in attention, will power, improvement in habitual method of recording facts, elements which may be disentangled from the whole—

all have been offered as plausible explanations of transfer. Indeed it seems to be a very tangled-up question. The point of view that I shall take is that transfer takes place when there are identical elements and that the amount of transfer depends upon the number of identical elements which are reacted to as being identical. It even seems plausible that the theory of identical elements proposed by Woodworth and Thorndike may include all the rest. It gives a more precise formulation of what in others is vague. Let us take, for example, "Generalized Experience" so ably championed by Judd. This statement leads early to another question, what is generalized experience? When we begin to analyze this generalized experience it appears that we come upon certain elements of experience. Thus the physicist is reacting to the element of attraction in the law of gravitation, the zoölogist to the element of motility of animals, the historian to the element of causal relation. In the long run these, psychologically, are as simple and as truly "elements" as the perception of a rabbit or a piece of iron. The ordinary process of generalization consists in learning to react to certain essential elements and to neglect others. As an illustration let us take the word "chair." In the beginning experience with a chair or chairs was perceptual. A chair was large or small, made of yellow or brown wood with a back of a certain height, but further experiences with chairs leads one to neglect in turn rockers, size, height, wood, or other material, etc., finally landing on the essential characteristic, the element of singleness of seat and the element of back—these two being the essential elements in the solution. In a world of changing experiences there is little question but that these general elements are of surpassing importance and should be carefully developed. They have the most widespread transfer effect and further attention will be paid to them in the next chapter.

Types of Identical Elements

1. Identity of content. Transfer takes place from adding 3+4 to a life situation because this combination appears in adding up a column of figures to determine the amount of the bill at a restaurant. Some psychologists would object to calling this item transfer at all.

2. Identity of procedure or method offers probably one of the greatest opportunities for transfer. The method of neglecting irrelevant details in memorizing or, conversely, of choosing the fitting one, the method of seeking meaning in study, the scientific method or attitude which inclines one to gather and interpret data and to look at the facts impartially are illustrations of the finest outcomes of the school work. Methods of study, too, are common to most of the material in high school as well as in college and life.

The transfer of the method of attack may have been the important element in Winch's transfer of reasoning from problems in arithmetic to problems in logic. This may have been a method of analysis whereby the question was held in mind until each probable solution could be applied. Transfer in Thorndike and Woodworth's experiments were reported as being due to "ideas of method and habits of procedure and also (2) of facility with certain elements that appeared in many other complexes." (Thorndike, Vol. II, p. 298.) One of these listed in number "2" was the learning to estimate areas by a mental standard rather than by an objective one. The discrimination between differences of saturation in one color transfers to discriminating between other colors because of identity of method of holding one color in mind while thinking of the next.

3. Closely related to the above is the transfer of identical moods or attitudes. These are usually attitudes plus a strong feeling accompaniment. Thus the school needs to build up the right attitudes towards one's country, one's

state. These are very closely related to Bagley's "Ideals Consciously Acquired," and to transfer of attitudes of success.

4. Transfer of identical elements of a very *general nature* which is involved in the understanding of a principle and its application. The transfer of training in throwing darts at a target from one depth to another appears because of the general element of refraction appearing in both.

5. It is possible that ideals consciously acquired, generalized and given an emotional coloring, may transfer under all conditions, e. g., honesty, truth.

QUESTIONS AND EXERCISES

1. Plan out in detail an experiment to test the effect of memory on reasoning.
2. What would determine its reliability?
3. What criteria might one use to decide whether the experiment was adequate or not?
4. What weakness might appear?
5. What assumptions does the believer in identical elements make about the organization of habits?
6. Can a habit be generalized? (See Colvin, *The Learning Process*, pp. 49, 237.)
7. Just what would "the sympathetic interaction of allied memory functions" mean from the point of view of scientific correctness?
8. What advantages and what disadvantages, i. e., from the point of view of subjects, amount of transfer, etc., can you see in experimenting with children in the elementary school?
9. Suppose one should argue that those who had studied Greek had been very successful and that the study of Greek had produced this result, would this be a conclusive argument?
10. What is meant by the error of selection?
11. What is negative transfer? How is it caused?
12. Summarize the main findings of Sleight. To what extent does the experiment satisfy our criteria?

13. Compare Judd's and Thorndike's view on the transfer of training.
14. In what three phases of mental life are transfer experiments selected for purposes of illustration?
15. Conclude as to the amount and direction of transfer.
16. If there was some truth in the observation of all keen observers what could an individual mean by "sharpening the mind" ?

REFERENCES

Bagley, W. C. *Educational Values*, p. 189, Reports on C. R. Squire's experiment on the transfer of neatness and accuracy, 1911.

Bennett, C. J. C. "Formal Discipline," *Teachers College Contributions to Education*, 1907.

Coover, J. E., and Angell, F. "General Practice Effect of Special Exercise," *American Journal of Psychology*, 1907, Vol. *18*, pp. 327–340.

Colvin, S. S. *The Learning Process*, Chapters XIV and XV, 1914.

Dearborn, W. F. "The General Effects on Special Practice in Memory," *Psychological Bulletin*, 1909, Vol. *6*, p. 44.

Ebert, E., and Meumann, E. "Ueber Einige Grundfragen der Psychologie der Uebungs phänomene in Bereiche des Gedächtnisses," *Archiv. für die gesamte Psychologie*, 1905, Vol. *4*, pp. 1–232. See also Thorndike's *Educational Psychology*, Vol. II, pp. 369–376, and Sleight, W. G., "Memory and Formal Training," *British Journal of Psychology*, Vol. *4*, pp. 389–395.

Fracker, G. C. "On the Transference of Training in Memory," *Psychological Review*, Monograph Supplement, 1908, No. 38, pp. 56–102.

Gates, A. I. *Psychology for Students of Education*, Chapter XV, 1923.

Heck, W. H. *Mental Discipline and Educational Values*, 1911.

James, William. *Psychology*, Vol. I, pp. 666–668. Notes on Memory Experiments first on himself then on Dr. W. H. Burnham and others, 1890.

Judd, C. H. *The Psychology of High School Subjects*, Chapter XVII, 1915.

Ruediger, W. C. "The Indirect Improvement of Mental Function Through Ideals," *Educational Review*, 1908, Vol. *36*, pp. 364–371.

Ruger, H. A. *The Psychology of Efficiency*, 1910 and also 1926.

Rugg, H. O. *The Experimental Determination of Mental Discipline in School Studies*, 1916.

Scholckow, and Judd, C. H. "The Relation of Special Training to General Intelligence," *Educational Review*, 1908, Vol. *36*, pp. 28–42.

Sleight, W. G. "Memory and Formal Training," *British Journal of Psychology*, 1911, Vol. *4*, pp. 386–457.

Starch, Daniel. *Educational Psychology*, Revised edition, Chapter XIII, 1927.

Thorndike, E. L. *Educational Psychology*, Vol. II, Chapter XII, 1913.

Winch, W. H. "The Transfer of Improvement in Memory in School Children," *British Journal of Psychology*, 1906–1908, Vol. *2*, pp. 284–293; 1909–1910, Vol. *3*, pp. 386–405.

Winch, W. H. "The Transfer of Improvement in Reasoning in School Children," *British Journal of Psychology*, 1922–1923, Vol. *13*, pp. 370–381.

Woodworth, R. S. and Thorndike, E. L. "The Influence of Improvement in One Mental Function Upon the Efficiency of Other Functions," *Psychological Review* 1901, Vol. *8*, pp. 247–261, 384–395, 553–564.

CHAPTER VIII

TRANSFER OF SCHOOL SUBJECTS

In the previous chapter it has been apparent that training in one function transfers to another function when there are identical elements common to both. As the elements of similarity increase the transfer effect increases; as they decrease it decreases. This much seems clearly deducible from the experimental evidence. On the contrary there is most probably little if any general mental development whereby all functions would be improved from the improvement of any specific mental function.

If we hope to find transfer from school subjects to various other mental functions, to the school situation, to life itself, we shall expect to find it only when the school subject resembles in some way these other functions. And particularly in the elementary school the more nearly these subjects of instruction resemble life's other situations either in material or in method the more transfer effect shall we expect. The more the spelling in school is exactly like that of everyday life, the more nearly school work in English approximates that being used and to be used, the more nearly arithmetic is like life experiences in buying and selling, the greater will be the transfer effect.

Those schools, indeed, who have made civics—community civics—a study of the government and general welfare of that community, who have projected their history into the present, who have studied the air and water about them, who have made the elementary school not so much a preparation for life as life itself, have had the greatest transfer effect from school to life. Some psychologists would not call this *transfer* at all. In a sense it is merely recognizing the inefficiency of transfer claims and placing the most common of life's situations in the school. We shall now review some of the experimental evidence in the field of elementary education.

Transfer in Elementary School Subjects

In the first place, Chapter VII contains the reports of two investigations which bear on the present problem. Neatness, acquired in one subject, we have seen (p. 211), transferred to other subjects whenever it is made an ideal, and reasoning in arithmetic transferred to logical situations (see p. 209). These facts we have already considered. Our present task is to report a carefully wrought out study of the transfer effect of teaching grammar upon certain other types of mental abilities. The experimenter (Briggs) undertook to discover the influence upon seventh grade children of the intensive study of grammar. In the first place he summarized the claims for formal grammar as follows: "It is held that work in grammar trains children,

A. With Rules or Definitions:
  1. to see likenesses and differences
  2. critically to test a definition
  3. thoroughly to apply a definition
  4. to make a rule or definition.

B. With Reasoning:
  5. to test reasons
  6. (a) to take from a mass of data all that are necessary and to use them in reaching a judgment
     (b) to demand all necessary data before drawing a conclusion
  7. to reason in other fields, e. g., in arithmetic
  8. to reason syllogistically
  9. to detect "catches."

Having settled on these claims for formal grammar the next step was to select tests which would measure them satisfactorily. Likenesses and differences were tested by presenting lists of words, numbers, leaves of trees and sentences, the individual elements of which were alike in some way. Children were then asked to discover these similarities. Here we shall present only one illustration, Test I.

"One-half of the following sixteen words are alike in one respect and in that respect unlike all the other words in the list. Find these eight words and mark them with a check (✓).

biscuit
oxen
scholars
pole
pirate
geese
knives
frame
mountain
fathers-in-law
vessel
children
men
factory
table
mice."

Ten tests altogether were used to test out the ability to see likenesses and differences; four sets of definitions, to test the children's ability critically to test a definition; ten tests were used to test out the ability to apply a definition; and two, to test out the ability to make a rule or definition. In a similar manner, great care was exercised in selecting tests for reasoning ability of all types represented in "B" above. All told fifty-four different tests were given.

The subjects (two seventh grades) were carefully divided into two equivalent groups, I and II, on the basis of intelligence as determined by the pooled estimates of teachers and by means of tests of mental alertness. At the beginning of the experiment all the children were given the tests just described. Group I was now taught grammar intensively for three months, while Group II studied language and composition. At this point all were tested again, then Group I that had been studying grammar now studied composition and language for three months and Group II, that had been studying composition and language, now studied grammar. At the end of this period all children were tested again. We thus have in each class the cause (grammar) acting and again withdrawn.

Except in the case of the ability to see likenesses and differences in which the group studying formal grammar were ahead in eight out of the thirteen comparisons, except for this one, then, there was no improvement in any of the functions measured which could be attributed directly to the study of formal grammar. Furthermore, the results were found to be substantially the same when the tests were tried on five public schools in Illinois some of which emphasized grammar and others of which did not.

These results are a bit startling when we think of the elaborate claims once advanced for the study of formal grammar. But the results are all the more convincing because such great care was used in collecting a large variety of functions related in varying degrees to the class work in grammar.

Does improvement in arithmetic computation transfer to arithmetic reasoning and to what extent? The answer to this question has been recently attempted in a series of experiments with school children (Winch). Only one of these experiments will be reviewed here. In this case six preliminary tests in reasoning were given to 72 boys in a municipal boys' school in London. Their average age was 10 years and three months. Two groups equivalent in reasoning ability in arithmetic were formed. Examples of these tests of reasoning used in one experiment are:—

1. Five books each contain 419 pages. How many pages are there in all the books?

2. If 24 pounds of bacon cost 18*s*., and 16 pounds of sugar cost 5*s*. 4*d*., how much more is the bacon per pound than

the sugar? One of these groups was practiced thirty minutes a day for ten days in arithmetic computation until its members had improved 40 per cent. Two of the examples used in practice were:—

3. £9 8*s.* 7½*d.* × 9
4. £96 14*s.* 4½*d.* ÷ 5

The other group practiced drawing. At the end of this practice six further tests were given in arithmetic reasoning and the improvement of the two groups compared. The author's statement is: "Taking the groups as wholes and working from the individual figures, we find that Group A—the nonpracticed group—obtained an average score of 42.2 marks in preliminary tests, with a mean variation of 14.6 and group B obtained an average score of 42.0 with a mean variation of 14.8. In the final tests Group A scored an average of 45.7 (mean variation 14.2), and Group B an average of 45.3 (mean variation 16.4)." From four series of experiments Winch concludes that improvement in accuracy in arithmetic may take place without any certainty of improvement in reasoning in the same subject.

From the rather meager experimental knowledge which is extant concerning the disciplinary effect of elementary school subjects—ideals of neatness, arithmetic reasoning, arithmetic computation, grammar—the conclusion could be drawn that the training transfers into a rather narrow area. Since this is so, the task for the elementary school seems clear. Select material which most nearly parallels life's situations and develop in the minds of the pupils the relation between school and life.

For many years the theory of formal discipline exerted a tremendous influence upon the materials and methods of the elementary school. Long, hard arithmetic problems which even sent the young teacher to bed in tears because of her inability to cope with them, rules of grammar which every one speedily forgot, words to be spelled that never graced the pages of anybody's writing, sad, religious reading material—all these were placed in the curriculum of the elementary school to discipline the mind. School in the earlier days must certainly have been a gloomy place ruled over by teachers who relied rather wholeheartedly upon the switch.

Let us contrast this rather drab picture with some of the more modern conditions which have resulted, at least in some degree, from modifying the idea of formal discipline. Arithmetic problems resemble the situations which life offers. Grammar in our best schools has been reduced to a minimum and the rules have been arrived at inductively. The words to be spelled are chosen from the most frequently used words in the English language. The reading material is selected because of its interest to the children and because it fulfills the child's ordinary experience. Discipline now comes in the carrying through a desirable task because it is desirable and worth-while and valuable and not because one dislikes it. Thus the doctrine of identical elements believes that transfer may appear whenever the same elements appear in school and in life provided, (1) the common elements are presented and (2) the identity is pointed out to the pupil.

THE HIGH SCHOOL

The problems of mental discipline and the transfer of training loom very large in the high school. In this institution the subjects of instruction are not nor can they be made to be, so nearly like life's situations as can be done in the elementary school. For this reason the problems of methods of study, of ideals, of generalizing ability, in brief, of discipline, assume a more commanding position in choosing the subject matter and methods of high school studies. If certain subjects have more transfer value it is important to discover which they are and just how much and in what direction there is transfer.

One student (Thorndike) has made a very serious attempt to solve this problem. Pupils from Grades X, XI, and XII, numbering 8564 in 18 high schools located in ten different cities, were studied. The problem was to discover the general capacity to reason gained in studying for one year one subject. A series of mental tests was given to these 8564 pupils first in May, 1922, and again in May, 1923. Alternate forms of the tests were used so that the pupils who took Form A at one sitting took Form B at another. The test used was the one devised by the Institute of Educational Research of Teachers College, Columbia University, and consists of fifteen different parts made up of such tests as arithmetic problems, absurdities, various forms of analogies, and some tests of spatial relations. The proper weightings of the tests were carefully worked out. In addition the equality of units on the tests was thoroughly checked up. In brief, we have a representative and reliable set of tests of mental alertness or of the ability to solve new problems or of mental discipline.

Against this battery of tests measuring the gain in general ability for one year were projected the courses taken. The hope was to find pupils who had three subjects alike and one different and by means of a series of such programs to discover for how much gain one subject was responsible, but so numerous was the number of possible combinations of subjects that as many as 1500 different programs having not more than fifty pupils each, resulted. It was calculated that 1600 pupils for each combination were needed to make the findings reliable. This plan was therefore given up and certain subjects were grouped together which, a preliminary investigation had shown, had produced approximately the same amount of gain. The procedure was then followed of finding programs three parts of which were alike and one of which was different and of subtracting the gain in the first from that in the second.

After allowing for, (1) the fact that boys gained about three points on the average more than girls, (2) that persons of high mental ability made the largest gain, and (3) that the average gain from May to May in the tests was 23, 11.9 of which being due to the mere taking of the test the second time while 11.1 was due to actual growth in mental ability, the following table was deduced:

TABLE XV

THE DIFFERENCE IN GAIN BETWEEN A PUPIL WHO TAKES A GIVEN SUBJECT AND A PUPIL OF THE SAME SEX AND INITIAL ABILITY WHO TAKES I OR NOTHING IN PLACE OF IT

(Thorndike, 1924)

		Corrected Weighted Average Difference in Points	*Rank*
II.	(Civics, Economics, Psychology, and Sociology)[1]	+.27	6
III.	(Agriculture and Biology)	−.90	10
IV.	(Arithmetic and Bookkeeping)	+2.92	1
V.	(Geometry, Algebra, and Trigonometry)	+2.33	3
VI.	(Latin and French)	+1.64	4
VIII.	(Stenography, Cooking, and Sewing)	−.47	9
IX.	(Chemistry, Physics, and General Science)	+2.64	2
D.	(Dramatic Art)	−.29	8
T.	(Physical Training)	+.66	5
I.	(History, Music, Shop, Spanish, English, Drawing, and Business)	.00	7

It will be noticed that Group I is zero gain in terms of which the others are expressed, i. e., the 2.92 (if I interpret it correctly) means that by taking arithmetic or bookkeeping the pupil gains 2.92 points in the intelligence tests, more than he would have gained had he taken history or music. If we consider the third column (that of rank) it is seen that arithmetic and bookkeeping rank first; the natural sciences second; geometry, algebra, and trigonometry third; and Latin and French, fourth.

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[1] The placing of these subjects into groups was obtained from a table showing relation of studies to gains measured by the relative frequency of the study in groups making various amounts of gains.

To permit the ready comparison with other types of gains I shall quote a series of short paragraphs from this article.

We then have as the effect of different programs:

21½ for the three courses in Science and one in Mathematics.
19 for one course each in Latin, French, Algebra, and Geometry.
16 for one course in Arithmetic, Bookkeeping, Stenography and Typewriting.
10½ for one course each in Cooking, Sewing, Dramatic Art, and Physical Education.
20½ for the best 1 per cent in initial ability.
1½ for the lowest 1 per cent in initial ability.
11 for the average white pupil.
1½ for the average colored pupil.

These figures are computed from Table XV by adding up the scores for each subject and then adding to this sum 11.1, the average gain on the intelligence tests for one year's growth. Thus for the first group we have three courses in natural science with 2.64 points per course and one in mathematics with 2.33 points. These together make 10.25 points, which when 11.1 points are added give us 21.35 points. It is thus seen that the maximum differences due to intelligence (20½ – 1½) are much greater than those due to differences in courses included in the program (22½ – 10). Indeed this former factor is most probably the determining one in the growth of mental ability.

Quite recently (Broyler, Thorndike, Woodyard—1927) this study has been repeated using 5000 pupils in the investigation. The results with one significant difference and a few minor ones resemble closely those of 1924. The large difference occurred in the civics, economics, etc., group which ranked sixth in 1924 and first in 1927. The average results from the two groups are presented in Table XVI.

TABLE XVI

Estimated differences in gains in comparison with I or nothing, for persons of the same sex and ability. Group I consists of business, drawing, English, history, music, shop, and Spanish. This group would rank just below Latin and French. Meaning of figures given in text.

(Broyler, Thorndike, Woodyard, 1927)

	Average of Two Investigations Including Results from over 13,000 High School Pupils
Algebra, geometry, trigonometry	2.99
Civics, economics, psychology, sociology	2.89
Chemistry, physics, general science	2.71
Arithmetic, bookkeeping	2.60
Physical training	.83
Latin, French	.79
Stenography, cooking, sewing	−.14
Biology, agriculture	−.15
Dramatic art	−.48

In conclusion it would seem that there are essential differences in high school subjects in their capacity to produce changes in general mental ability, but these differences are small compared with the differences between the gains made by the bright pupils on the one hand and the dull ones on the other. The gain for taking one subject for one year was about 2½ points on the average. Compare this, for example, with the three points greater gain by boys. The difference producible by a careful selection of courses is then about three times as great as that between boys and girls. It seems reasonable to conclude with Thorndike, "When the good thinkers studied Greek and Latin, these studies seem to make good thinking. Now that the good thinkers study Physics and Trigonometry, these seem to make good thinkers. If the abler pupils should all study Physical Education and Dramatic Art, these subjects would seem to make good thinkers. These were, indeed, a large fraction of the program of studies for the best thinkers the world has produced, the Athenian Greeks. After positive correlation of gain with initial ability is allowed for, the balance in favor of any study is certainly not large. Disciplinary values may be real and deserve weight in the curriculum, but the weights should be reasonable."

A somewhat different interpretation might be given these results than the one that Thorndike gives. After provision was made for the practice effect it was calculated that a growth of 11.1 points was the average amount directly attributable to mental growth. Now by the selection of a course in business arithmetic, algebra, chemistry, and French instead of the ordinary gain of 11.1 points one would get 20.63 or a residual gain of 9.53 points which, be it remembered, were obtained by a judicious selection of subjects. While this is not as great as the difference due to differences in intelligence (19 points) it still stands as a substantial effect of the disciplinary effect of school subjects. This might in a period of four years so train an individual that he could stand to a marked degree above the common run of individuals. One might even argue from a careful inspection of the tables that the disciplinary effect of subjects was considerable, that it makes a vast deal of difference from this very standpoint whether or not a pupil takes Dramatic Art, Agriculture, Stenography, and English, or Trigonometry, Physics, Latin, and English.

Transfer Effect Resulting From the Taking of Certain High School Subjects

In a few of the high school subjects studies have been made of their transfer effect. These will be reviewed in order to get concrete knowledge of the amount and direction of transfer.

Science. Does improvement in the observation and description of material of a scientific nature transfer to the observation and description of material (a) of the same general nature as the first and (b) of a somewhat different nature from the first? One investigator (Hewins, 1916) has attempted to solve this problem experimentally in the case of biology. Her problem was to determine the effect of practice in describing a lilac flower; box-elder leaf; stem, leaf, and flower of gill-run-over-the-ground; flower, stalk, and flower of the lily-of-the-valley; horse-chestnut flower; buttercup flower; mustard flower; dogwood flower; deutzia flower, and columbine; I say of practice in describing these upon the ability to describe such material as:

horse-chestnut stem
picture
forsythia flower
10 syllables (nonsense)
lilac leaves
nonsense figure
geometrical figures
10 2-place figures
scouring rush
maple seedling
figure in air

In the second and third test series the material was changed somewhat but the types of materials to be described remained the same The subjects were 34 boys and 50 girls of an average age of about 13 or 14 in the first year of a New York high school. Table XVII expresses the results in such a manner that comparisons may be made with other experiments.

TABLE XVII

TRANSFER EFFECT OF PRACTICE IN DESCRIPTION OF CERTAIN BOTANICAL SPECIMENS TO THE DESCRIPTION (A) OF OTHER SPECIMENS AND (B) OF MATERIAL OF A DIFFERENT NATURE [1]

	Biological Tests	*Nonbiological Tests*
Practiced Groups		
Boys	8.06	8.97
Girls	6.41	6.20
Average	7.23	7.58
Unpracticed Groups		
Boys	3.03	5.37
Girls	—1.24	5.60
Average	.89	5.48
Residual difference between practiced and unpracticed groups	6.34	2.10
Percentage gains over scores in first test series	33.9%	5.4%

It thus seems clear that the transfer is greatest when the identical elements are most numerous. The biological material in the tests of some cases was remarkably like the material in the practice series. For example, compare the process of describing a horse-chestnut flower with that of describing lilac leaves. The percentage of transfer is much the same as that found by Thorndike in discrimination and of Winch in transfer of arithmetical reasoning. In general her conclusions fall in with the rest: that there is considerable transfer to material which is similar.

Latin. The discussion concerning the transfer effect of the learning of Latin has gone on intermittently for the last forty or fifty years. Only recently have sufficient scientific investigations been completed to give us an opportunity really to evaluate the transfer effect. Many of these studies have been stimulated by the Classical Investigation. These studies will be reviewed and an attempt made to evaluate them in a concluding discussion.

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[1] From Starch, after Hewins ('16). *Educational Psychology*, p. 288 (Revised Edition), 1927. The Macmillan Company. Reprinted by permission.

A. *Knowledge of English Words.* The study of Latin by all means has some effect on the meaning of English words. To determine just how great this effect is, has been the purpose of several investigations.

1. Carr's Latin Tests were given (by Thorndike and Ruger) to (a) 2575 high school pupils in first year Latin and to (b) 2944 first year pupils who were not studying Latin. The tests were given at the beginning, the middle, and end of the year's work. The Carr Latin Tests consists of 50 words. Twenty-five of these are derived from words contained in Henmon's Latin Vocabulary Test, and twenty-five are not of Latin origin. An illustration from this test is as follows: The *novelty* of the situation appealed to him. Romance, strangeness, beauty, fun, quietness, "now try to decide which of these words or phrases most nearly explains the meaning of the word printed in italics in the sample sentence. Draw a line under that word or phrase."

TABLE XVIII

A Comparison of Results by Two Methods of Computing Superior Gains of Latin Pupils over Non-Latin Pupils
(Thorndike and Ruger, 1923)

Method Employed	*In Latin Words*		*In Non-Latin Words*	
	Half-year Superior Gains	*Year Superior Gains*	*Half-Year Gains*	*Year Gains*
Group I				
Method of Pairing (Corrected)	2.35	3.45	0.125	0.025
Method without Pairing	2.4	3.5	0.0	−0.2
Group II				
Method of Pairing (Corrected)	2.04	2.84	0.00	−0.10
Method without Pairing	2.1	2.9	0.1	−0.3

Group I took initial test during the first 13 days of school.
Group II took initial test between 14th and 27th days, inclusive.

We may accept the results of these findings: "In the words of Latin derivation the Latin pupils gain in the year about 2$^1/_2$ or 2$^1/_3$ times as many words as the Non-Latins. In the words not of Latin origin there is no demonstrable difference between the pupils who studied Latin and those who do not" (417–418).

2. In this study from which quotation has just been made it seemed clear that the ability to define words derived from Latin was substantially increased by a year's study of this language in the usual way. The next studies attempt to determine whether or not even greater improvement might not be attained by consciously directing the teaching to a study of the derivation of words both within and without the Latin class. The first (Hamblen's) attempts to determine the relation between the amount of transfer from Latin to a knowledge of English words which takes place when Latin is taught in the ordinary way, over against the amount transferred when a conscious attempt is made to teach the pupils the derivation and history of words for one-fifth of the time each day during the regular Latin period. The table below shows the results from 118 pairs of high school pupils, paired according to their standing on the Terman Group Test of Intelligence.

TABLE XIX

The Year Gain in Vocabulary of the Control Group (Latin in Ordinary Way) and the Experimental Group (Latin plus Derivation)

(Hamblen, 1925)

	Carr Test Latin	*Carr Test Non-Latin*	*Total*	*Thorndike Test* [1]
Control Group	4.05	2.77	6.82	6.74
Experimental Group	8.12	3.49	11.61	10.66

[1] The Thorndike test of word knowledge consists of 100 commonly used words to be defined, the definition consisting of recognizing among

It is thus seen that careful attention to the teaching of derivations produces an improvement in the ability to define words, 50 per cent greater than that which occurs when Latin is taught in the ordinary way. From these data we may conclude with the author:

> " These results show a year gain of about eleven words when progress is measured by either of these tests and a gain of about eight words of Latin origin when this gain is measured by the Carr Test.
>
> To sum up, the results of this study seem to show that a pupil studying one year of Latin may be expected to make a small gain in a knowledge of Latin-derived words, even without the help of textbook or teacher, although it cannot be stated to what extent this gain represents the normal growth in English Vocabulary made by the average ninth-grade pupil, and to what extent it is the result of automatic transfer; that this gain can be greatly increased through the use of a suitable textbook and of appropriate methods of teaching; that a pupil's notebook and a teacher's derivative list are important aids in the teaching of derivatives; that approximately one-fifth of the total class time may profitably be given to work in derivation; and that the giving of time and attention to derivation increases rather than hinders progress in ability to comprehend Latin."

Haskell proceeded in a manner similar to that of Hamblen, but his problem was a more complex one. He wanted to discover the relative amount of improvement of (a) those who studied Latin with an emphasis on derivations (the Experimental Latins), (b) those who studied Latin in the

five words that word which means the same or nearly the same as the word defined, e. g., *Builder*—employee, hamlet, maker, fund, swindler. The words have no particular relation to Latin as have those of the Carr Test.

ordinary way (the Control Latins), (c) those who studied English with training in English derivations (the Experimental Non-Latins), and (d) those who studied English but no Latin (the Control Non-Latins). Arrangements were made for a careful study of each of the conditions. The experiment began with 1800 pupils but on account of mishaps of various kinds there remained something over 500 who were included in the experiments. Pairings were usually made from the scores which pupils received on the Terman Group Test. In pairing we take two students of equal capacity in some trait and place one in the Experimental Group and the other in the Control Group. It is important to remember that there was a sufficiently large number of pairings to make the results reliable.

TABLE XX

The Greater Number of Words Each Group is Able to Define than the Group With Which it is Compared. Comparison is First Made on the Thorndike Test of Word-Knowledge and Second on Carr's English Vocabulary Test. The Time between Tests was One Year. We Would then Read the Table:—The Experimental Latins, on the Average, Gained in one year Sufficient Knowledge to Define 3.5 More Words than the Control Latins, and 3.4 More Words than the Experimental Non-Latins When the Gains were Measured on the Thorndike Test, etc.

(Haskell, 1923)

	Year (Thorndike) Average Weighted Superiority			*Year (Carr) Average Weighted Superiority*		
	Control Latins	*Experimental Non-Latins*	*Control Non-Latins*	*Control Latins*	*Experimental Non-Latins*	*Control Non-Latins*
Experimental Latin	3.5	3.4	5.0	4.4	5.3	7.
Control Latin			1.6			2.4
Experimental Non-Latin			1.4			1.2

The author concludes that the improvement in English Vocabulary of those not taking Latin (the Non-Latins) is very small, that if a study of the derivation of words is added to the work in English a little but not much larger improvement takes place, and that a year of Latin in the conventional way improves the vocabulary only a little more than when etymology is studied in the English class. On the contrary he concludes:

> "That the normal and conventional Beginners' Latin Course in the ninth grade produces *with conscious effort in the study of Etymology approximately one-fifth of the time of the class period* a large and significant contribution to the range of the English vocabulary of the Latin pupil as determined by measurements with small groups in four Philadelphia high schools with the Thorndike and Carr English Vocabulary Tests."

B. *Effect of Latin on Reading*. The study of Latin for one year has a demonstrable effect on reading. If two groups of equal ability are formed and if one group studies Latin for one year while the other takes some other subject the gain in reading is in favor of the first group. Thorndike on measuring the difference in scores between two givings of the Thorndike-McCall Reading Tests found that those studying Latin gained 1.7 points above those not studying it.

TABLE XXI

COMPARISON OF THE AVERAGE YEAR GAINS OF LATINS AND NON-LATINS HAVING EQUAL BEGINNING SCORES

(Thorndike, 1923)

Initial Score	*Superior Gains of Latins*
49	2.3
51	2.6
53	2.1
56	1.6
58	1.2
60	1.6
63	1.7
63	1.4

At all levels of the test the Latin pupils gain more than the Non-Latins, but the gain seems the greatest among those who made the lower scores.

C. *Effect of Latin on Spelling.* It has been well demonstrated that of the 17,303 most commonly occurring words among the 7,000,000 running words examined (Thorndike-Grinstead) 52 per cent are derived from Latin, while 11% more are derived from Greek through the Latin, making a total of 63% affected by Latin. Since such a large number of English words are derived from Latin what would be the effect of improvement in Latin upon an individual's ability to spell? The approach to this problem may be made through two ways, (1) the statistical, and (2) the experimental.

1. *The Statistical.* Pupils who study Latin for one year gain slightly more in spelling words derived from Latin than those who do not take Latin. For example, Coxe found that when the Buckingham-Coxe Spelling Test was given to the pupils of 58 schools in the beginning, middle, and end of the year those who studied Latin gained on the average 3.6 words per year; while those who did not study Latin gained 2.6 words. In cases of the words which were not of Latin origin there was no demonstrable difference between the two groups.

2. *Experimental.* In this instance, just as in the instance of teaching Latin derivation, whenever the teaching of the relation between Latin and spelling was made a conscious aim improvement took place. Various methods were tried which included (a) teaching of Latin in ordinary way but with no emphasis on spelling, (b) much emphasis on Latin derivations but no rules or principles developed, (c) a development of both the rules and principles of spelling, and (d) two English classes the one with Latin derivation taught, the other with no Latin. It was clearly shown that the conscious study of the relation between Latin and English spelling with the development of rules and principles was the best method of all those tried. If the gain in a Latin class especially trained in derivation ability to spell words is represented by 10, those taking Latin but who have not had the special training in Latin derivation will score about 6.7 (Coxe). The author concludes:

> "As to the methods, we can say that Latin study, even with no special emphasis upon its relation to English spelling, does have an appreciable effect. When the similarities between Latin and English spelling are pointed out, the spelling results are still further increased but the greatest results can be achieved when we develop rules which govern the spelling of Latin derivatives. Further, this last method produces the least interference with the spelling of Non-Latin words."

Transfer occurred in a negative direction when unusual training in Latin derivations produced a deleterious effect on the ability to spell words not derived from Latin.

It appears that in the study of spelling the greatest influence would be had by emphasizing the learning of the root words. One investigator (Lawler) has shown that 65 per cent of the misspelling in Grades VII, VIII, and X are remediable by a knowledge of Latin in that 42 per cent of those are directly related to a knowledge of root words, about 13 per cent to prefixes, and 10 per cent to suffixes. It thus seems clear that the identical elements are composed largely of root words. Thus we see before us, definitely determined, the most common identical elements between Latin and Spelling.

D. *Effect of Latin on the Knowledge of the English Language.* Some evidence has accrued that one's knowledge of the English language is favorably affected by the study of Latin.

1. Thorndike found that those who had studied Latin made an increase of 10 per cent over those of the same initial ability who had not studied Latin, in stating the principles governing correct usage. In addition Bates showed that those who had studied Latin were superior to those who had not, in scores in a grammar test.[1]

2. Another investigator (Dallam) obtained the general scholastic average of 114 pupils from which she was able to select two groups of seventeen pupils each, equal in general scholarship. Tests of reading ability were also used to make sure about the general equivalence of the two groups. Papers of the thirty-four pupils were placed in one group and carefully graded in spelling, reproduction, dictation, derivation, definition, composition, and grammar. The table below shows that the Latin pupils' papers were ahead in six out of seven abilities.

TABLE XXII

Marks in Per Cents of Latins and Non-Latins in Various Language Traits

	Grammar	*Spelling*	*Reproduction*	*Dictation*	*Derivation*	*Composition*	*Definition*
(Non-Latin) Modern Language	59.7	89.2	63.0	96	29.3	71.8	73
Latin	67.6	90.7	65.9	95	52.0	75.4	75.2

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[1] *Classical Investigation,* Vol. I, p. 50.

Again, the marks in Latin were correlated with those in spelling, reproduction, etc., while those who had studied modern languages had their scores in these subjects also correlated with marks in spelling, reproduction, etc.

Coefficients of Correlation between Marks on Latin and on Modern Languages and Certain Language Traits

	Spelling	*Reproduction*	*Dictation*	*Derivation*	*Definition*	*Composition*	*Grammar*
(Non-Latin) Modern Language	.09	.19	−.04	−.02	.23	.11	.28
Latin	.05	.15	−.16	.13	.15	.28	.46

With grammar only is the coefficient large enough to be reliable. There does seem to be a substantial relationship between marks on Latin and scores on English grammar.

E. *Effect of Latin on English Composition.* The answer to this question is more indirect than those given to the previous questions and must be inferred from the data presented. The general result seems negative, i. e., the process of translating Latin into English is such a tortuous process that when it arrives in English this latter is so twisted that much of the product so obtained is unworthy the name of "Good English" and must have for itself a new name, "Translation English," or even "Not English." Two investigations agree in general in their findings. One of these is concerned with pupils who have taken Latin for at least 2½ years; the other, with those who have studied Latin for at least four years.

1. The first of these (Miller and Briggs) collected more than three hundred translations of prepared passages in Cicero from 14 public high schools so distributed as to include representation from city, town, and villages and one preparatory school. These translations were done in

class on material which had been assigned for that day. All pupils whose records were used had studied Latin for at least 2½ years. The results were deplorable. Thirty-four per cent of the three hundred complete translations were in the judgment of competent teachers unacceptable as English, e. g., "So much did I accomplish when you were repulsed by the Consul as an exile you are able to ruin the republic and to vex the Consul and that this crime committed by you should be called piracy rather than war." Authors agree that 75 per cent of all the translations which were done after assignment and preparation either convey no meaning or else convey meaning in such a manner as assuredly to do more harm than good to English expression.

2. Similar results were found in the second investigation (Woodring). This differs from the preceding in using translations of a new passage of Latin by students who were standing the entrance examinations prepared by the College Entrance Examination Board. These students you will note had studied Latin for four years, were the fourteen out of the hundred who had begun Latin and from whom five would take further Latin at college. One hundred fifty cases were selected for special study; fifty from those who received the highest grades (A); fifty from the middle group (B); and fifty from the lowest group (C).

TABLE XXIII

Shows Percentages of Papers which Contained Good English, Translation English, and Unacceptable English

(Woodring, 1925)

	Good English	*Translation English*	*English with no Meaning*
A (Highest Group)	74.5	13	12.5
B (Middle Group)	22.5	32.5	45
C (Lowest Group)	3	9.5	85.5

Table XXIII makes clear the differences among the groups in their use of English. The best group, those who find Latin an interesting game, does use good English in most cases. But even here the English is poor in 25 per cent of the cases. The middle group is certainly deserving of its name with over 32 per cent "Translation English" while the poorest group is indeed hopeless.

The following summary from this study is well worthy of consideration:

> "A comparison of the means of the Latin translations and the English compositions measured by the Hudleson scale with the Hudleson norm for the twelfth grade shows that the achievement in English Composition of the high school graduates is between the standards of the ninth and tenth grades. The high group is equal to the tenth grade standard; the middle group falls below the tenth grade norm; the low group is below the standard of the eighth grade. The English of the Latin translations falls to the standard of the fourth grade. The high group equals a tenth grade standard achievement, while the middle and low groups are below the standard for the fourth grade."

It would appear from these two investigations that the quality of English Composition is lowered by taking courses in Latin and the authors leave us with this impression. But the case against Latin in this particular is not proven. The only way this could be done would be to show by means of experimentation that as the study of Latin advances the quality of English Composition becomes poorer. This has not been done.

F. *Effect of Latin on Preparation for French and Spanish.* The question now before us is concerned with the effect of studying Latin on attainment in French. Three studies have been carried out in order to discover this relation.

1. One study (Henmon's) tested the pupils at the end of the first year of French with standard vocabulary and sentence tests. Latin pupils stood considerably higher than non-Latin, but this difference was discovered to be due, in large part, to the better general ability of the Latin pupils rather than to their having taken Latin. A small residual gain, however, remained which amounted in a vocabulary test of 50 words to .56 words for two semester Latin pupils, 2.10 words for four semester Latin pupils, and 4.58 for six semester Latin pupils. In the translation test consisting of twelve sentences this superiority in the case of the Latin pupils is .41 sentences for two semester pupils, .40 sentences for four semester Latin pupils, and 1.03 sentences for six semester Latin pupils. But the same tests run at the end of the second semester of French show little or no difference between the Latins and the Non-Latins.

2. In a second study (Cole's), correlation coefficients between the amounts of Latin pupils had taken in high school and the grades they received on first year French were computed. Two hundred twenty-three pupils had taken Latin in high school and French in the University. The correlation between the number of years Latin was studied and the French marks was .36 ±.04. It was thought that a probable reason for this coefficient was the common factor of intelligence which underlay the fact (a) that pupils continue in their study of Latin and (b) make better grades on French. When the relation between French and scores on intelligence tests was computed the coefficient was found to be .30, and between intelligence and number of years having pursued Latin in high school was $-.04 \pm .045$. It thus seemed clear that the .36 did not need to be corrected because of the factor

of intelligence.[1] In this study the question arose as to whether, after all, the Latin translated transferred to the French or whether the students who took Latin longer and made better grades on French simply possessed better personality qualities than those who took less Latin and did less well on French. The correlation between the years Latin was studied and general university grades seemed to bear this out. Further studies, however, showed that when four years of Latin were taken there was a specific training transferred to French which was not accounted for by a generally greater capacity for work.

3. A third study (Kirby's) corroborates in the main the findings of Cole in the case of 268 students but found instead of .36 a correlation of .23; between intelligence scores and French marks a correlation of .43; and between intelligence scores and the number of years Latin was pursued in high school, a correlation of .10. By making intelligence constant (see previous note) we find a correlation of .22 between the number of years Latin was pursued in high school and marks on French which shows a very slight advantage in favor of those who studied Latin. For the second semester marks the results were not much different.

In summary, Latin does seem to affect the pupil in such a way that he comes to his French a little better prepared than the pupil who has not studied it. On the other hand, a little more intelligence, a little more application and the small advantage is quickly overcome so that as Henmon

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[1] Let 1 = Number of years Latin was taken in high school
2 = Marks on French
3 = Marks on 'intelligence.' Then to make the factor of intelligence common by partial correlation we write—

$$r_{12.3} = \frac{r_{12} - r_{13}\ r_{23}}{\sqrt{1 - r^2_{13}}\ \sqrt{1 - r^2_{23}}}$$

Since r_{13} is practically zero, we get a partial r of .36.

has shown by the time the second semester has arrived the small advantage has been equalized by other factors.

Similar relations have been discovered between the time devoted to Latin in high school and consequent university marks in Spanish. The correlation between these two entities was found by Cole to be .28 (cf. with French .36); between Spanish and intelligence scores .36 (cf. French and intelligence scores of .30); and between amount of Latin in high school and intelligence, .27 (cf. French of – .04). When intelligence is made constant we get a very similar coefficient (.24), to the one found with French (.22).

SUMMARY

The claims for the disciplinary effect of school studies have been refined and stated quantitatively. Recent investigations have shown that transfer effects are not nearly so great as the advocates of the disciplinary effect of school subjects once thought, that sometimes instead of a hoped for gain there is a real loss. Instance the case of Latin translation and English composition. And yet the transfer effect is as certain as one could wish for in the elementary school. Reasoning in arithmetic transfers to logical reasoning, grammar transfers to ability to show likenesses and differences, neatness transfers provided it has been formed into an ideal. When we turn to high school subjects we find business arithmetic, history, science, geometry, and Latin definitely influencing general mental ability (the power to think abstractly); the study of first year biology influencing the ability to describe flowers, etc., and to observe more carefully the material of a nonbiological nature. And Latin, what of it? The effect of the study of Latin goes out in many directions, English vocabulary, spelling, reading, grammar, in brief, most language traits are affected by it. Its one harmful influence is most probably the production of a deleterious effect on the power to write English composition, although this last fact has not been demonstrated scientifically.

Out of all this experimentation some things are clear:

1. The transfer effect from any mental function to any other mental function, or from a school subject to any other subject or to life itself, may be substantially modified by conscious effort in that direction. Of this, there is no doubt. Once we have determined our objectives for the teaching of any subject we can proceed with some assurance that they will be attained. If teachers, for instance, in their teaching of Latin keep their eye ever single to the developing of an English vocabulary, then the transfer effect in this direction can be trebled. To obtain from geometry that precision in thinking, that feeling of hesitancy in making unsubstantiated statements, that rigor of proof—these matters must be learned as other things are learned. They must be examined part by part, they must be shown to appear in a large variety of situations differing among themselves but having this element in common; they must be shown in situations now with them present and now with their opposites present. In short, the teacher of debating must coöperate with the teacher of geometry in linking up the rigor of proof of geometry with the rigor of proof of debating.

2. Courses must have as many elements as possible identical with or at least very similar to life itself.

3. The derivation of English words must center on those most frequently used; the translation from Latin into English must be into good English if translation is to be done at all. The discipline attained from the historical imagination must be projected into the present. Pupils must be aided in seeing the effect of a knowledge of history in everyday life. There must be a more complete study of modern history, and history for history's sake must pass into history for humanity's sake—a social history. The science

work must explain the facts of everyday life and above all the scientific method of thought of withholding opinion until sufficient data are in, of getting more data, of keeping careful records, should be one of the most important identical elements in life and in science. Indeed it may be that the method employed in science work will be the most important one outcome from science courses. Sufficient detail has been presented to emphasize the importance of the use of life material in our subjects of instruction. This chapter may well close with a quotation from one of our wisest men, "Favor, therefore, the situations which life itself will offer, and the responses which life itself will demand."

QUESTIONS AND EXERCISES

1. Under what conditions does transfer take place?
2. How do these conditions apply to the teaching of grammar?
3. Why do you suppose an intensive study of grammar did not transfer to other functions involving reasoning?
4. List four objectives of the teaching of English. How many would transfer and under what conditions?
5. What studies in the last chapter bear on this one directly? Indirectly?
6. Which subjects have the greatest disciplinary value? How great are the differences existing between them?
7. Compare the differences in mental discipline due to school subjects with those due to intelligence. Why do you suppose the latter is so much greater?
8. Do you think Thorndike's conclusions entirely justified? Why?
9. Describe Miss Hewins' experiment on the transfer effect of Biology.
10. How much influence does Latin have on English vocabulary? What would be the accumulative influence of this in five years?
11. What per cent of the ordinary words are of Latin derivation? How were these words selected?

12. To what extent does the study of Latin transfer to English words of Latin derivation; to non-Latin words?
13. How much influence does one year of Latin have on ability to read, to spell, on knowledge of grammar?
14. Why is the English of the translation so poor? What per cent of the poorest third of a class write acceptable English, of the best third? What effect does the employment of such poor English have on English usage? What sort of translations should we accept? Why?
15. Summarize the main implications obtained from a study of this chapter. Emphasize particularly the importance of choosing the situations which life offers.

REFERENCES

General

Colvin, S. S. *The Learning Process*, Chap. XVI, 1914.

Starch, D. *Educational Psychology* (Revised edition), Chap. XIV, 1927.

Elementary School Subjects

Briggs, T. H. "Formal English Grammar as a Discipline," *Teachers College Record*, 1913, Vol. *14*, pp. 1–93.

Hoyt, F. S. "Studies in the Teaching of English Grammar," *Teachers College Record*, 1906, Vol. *7*, No. 5.

Winch, W. H. "Accuracy in School Children. Does Improvement in Numerical Accuracy 'Transfer'?" *Journal of Educational Psychology*, 1911, Vol. *2*, pp. 262–271; 1910, Vol. *1*, pp. 557–589.

High School Subjects

Bates, R. "A Controlled Experiment in the Teaching of English Grammar Through Latin." Master's Dissertation at the State University of Iowa, 1924. *Classical Investigation*, Part I, Chap. III.

Broyler, Cecil R., Thorndike, E. L., and Woodyard, Ella. "A Second Study of Mental Discipline in High School Studies," *Journal of Educational Psychology*, 1927, Vol. *18*, pp. 377–404.

Cole, L. E. "Latin as Preparation for French and Spanish," *School and Society*, 1924, Vol. XIX, pp. 618–622.

Coxe, W. W. "Influence of Latin on the Spelling of English Words." Doctor's Dissertation at Ohio State University, 1923. Also *Journal of Educational Research*, 1923, Vol. *7*, pp. 244–250; and 1924, Vol. *9*, pp. 223–233.

Dallam, M. Theresa. "Is the Study of Latin Advantageous to the Study of English?" *Educational Review*, 1917, Vol. *54*, pp. 500–503.

Hamblen, A. A. "An Investigation to Determine the Extent to Which the Effect of the Study of Latin upon a Knowledge of English Derivatives can be Increased by Conscious Adaptation of Content and Method to the Attainment of this Objective." Thesis, University of Pennsylvania, 1925.

Haskell, R. I. "A Statistical Study of the Comparative Results Produced by Teaching Derivation in the Ninth Grade Latin Classes and in the Ninth Grade English Classes of Non-Latin Pupils in Four Philadelphia High Schools." Doctor's Dissertation at University of Pennsylvania, 1923.

Heald, I. F. "The Relation Between the Study of Latin in High School and First-Year College French." Master's Dissertation, State University of Iowa, 1923.

Hewins, Nellie P. *The Doctrine of Formal Discipline in the Light of Experimental Investigation*, 1916.

Hill, J. L. "The Relation of the Amount of Latin pursued in High School to Success in First-Semester French in the University of Iowa." Master's Essay, State University of Iowa, 1924.

Kirby, T. J. "Latin as a Preparation for French," *School and Society*, 1923, Vol. XVIII, pp. 563–569.

Lawler, L. B. "The Potential Remediability of Errors in English Spelling Through the Study of High-School Latin." Dissertation, State University of Iowa, 1925.

Miller, S. P., and Briggs, T. H. "The Effect of Latin Translation," *School Review*, 1923, Vol. XXXI, pp. 756–762.

Newcomb, H. Edith. "A Comparison of the Latin and Non-Latin Groups in High School," *Teachers College Record*, 1922, Vol. *22*, pp. 412–422.

Rugg, H. O. *The Experimental Determination of Mental Discipline in School Studies*, 1916.

Thorndike, E. L. "The Influence of First Year Latin upon Ability to Read English," *School and Society*, 1923, Vol. XVII, pp. 165–168.

Thorndike, E. L. "The Influence of First Year Latin upon the Range of English Vocabulary," *School and Society*, Vol. XVII, pp. 20–32.

Thorndike, E. L. "Mental Discipline in High School Studies," *Journal of Educational Psychology*, 1924, Vol. XV, pp. 1–22, 83–98.

Thorndike, E. L., and Ruger, G. J. "The Effect of First Year Latin upon a Knowledge of English Words of Latin Derivation," *School and Society*, 1923, Vol. XVIII, pp. 260–270, 417–418.

Woodring, Maxie Nave. *The Study of the Quality of English in Latin Translations*, 1925.

PART II

PROBLEMS CONCERNED WITH INDIVIDUAL DIFFERENCES

CHAPTER IX

STATISTICAL METHODS

Introduction

Reference has been made on several occasions to the statistical method. In the first chapter it was pointed out that this is one of the more important methods of investigation in the field of educational psychology and that it is frequently employed in the method of parallel groups, the experimental method, and the questionnaire to test out the reliability of findings. Furthermore, specific measures such as the mean and the coefficient of correlation were also mentioned.

In the second place, considerable use in this text has been made of statistical procedures in presenting the fundamental data from which inferences have been drawn. Tabular material has appeared in connection with learning curves, learning school subjects, in the transfer of training and in other connections. In fact, wherever serious consideration has been given, almost in every case is there occasion to have recourse to statistical procedures.

In the third place, the discussion of individual differences which we are just now entering into, could not exist at all without the use of statistical procedures. Its advance has been contingent upon new statistical knowledge. In fact, no one can even read intelligently the literature on individual differences without an understanding of the elementary statistical information contained in this chapter. The moment the statement is made that an individual differs from others the question is immediately asked "What others?" and the second question follows hard on the heels of the first "and how great is the difference?" Now the "others" are usually the average of what children at that age or grade score, and the amount of the difference is usually the distance from the average frequently divided by a measure of scatter which gives the standard score. The relationship between traits, too, is an ever present problem, and relationship is expressed by the coefficient of correlation. For these reasons, the author has no apologies to offer for leading the student around a short, but rather rough, statistical detour, for through this procedure the learner will encounter only hard surfaced roads for the rest of his journey.

Statistical Methods

Scores measuring differences among individuals almost always come to us in a mixed up condition. One of the first tasks to be accomplished is the orderly arrangement of these quantities. For example, in a test of word knowledge students in a class in Education made scores as follows:

92
88
97
95
100
58
90
94
72
91
83
88
83
87
82
78
64
68
97
95
86
85
85
89
77
61
74
59

One student who makes a score of 78, asks what this means. From such an haphazard arrangement of scores no accurate answer can be given to his query. In order to give him a meaningful answer we might proceed to arrange the scores in a systematic way.

First find the highest score (here 100) then the lowest (here 58). From 100 to 58 there are 42 units. If we take one step for each unit we would get 100, 99, 98, 97, etc., down to 58 which will give 42 steps in all. For our purposes this will be too many. Suppose we, for convenience's sake, use steps of five. We now begin at 100 and drop by steps of five until the lowest score is included (Table XXIV).

Before we actually begin arranging the scores we shall have to decide what each score means. Scores ordinarily are either *discrete* or *continuous*. *Discrete*, if there are definite gaps between, as one person, two persons, three persons; *continuous*, if the scores are finely divisible so that they approach ever so closely the next score, as, for example, in the measurement of length five inches may be increased by .1, .2, .3, .4, and so on to .9 and .99 or even .999 until the measurement is any desired closeness to six inches. *Mental measurements* are usually *continuous*. Our 55 at the foot of the table means in this case from 55 up to but not including 60, i. e., 55, 56, 57, 58, 59, and even 59.99 would fall at 55.[1] Suppose we proceed then to classify our scores. The first one is 92, where shall this go? At 90, of course, since 90 stands for all scores between 90 and 94.999. We thus check off 92 and make a tally by 90 to the right. Eighty-eight belongs at 85; 97 belongs at 95; 95 at 95; 100 belongs at 100; 58 belongs at 55; 90 at 90 and so we go until every individual score is represented in the table by a stroke. We then total these tallies into a column marked "frequency" or with the letter "f." We thus get a "Table of Frequency" which shows how many persons (column f) made each score. We may then read down the table that one person made a score of 100 on word knowledge, four made scores between 95–100; four made between 90 and 94; seven between 85–89; and on down the table until only two made a score of 55 to 59. Now by looking at our table we answer the student whose score is 78 as follows: "Nineteen out of 28 were above you and seven below you while one student scored about the same as you did."

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[1] There are other ways of considering steps. These may be found in any good treatment of statistics.

MEASURES OF CENTRAL TENDENCY

But suppose our student pressed his point by asking if he were up to the average or below the average. We have not determined these measures yet. The most common measures of central tendency are the arithmetic average, or mean, the median, and the mode, the three of which we shall now consider, taking the median first.

THE MEDIAN

TABLE XXIV

ILLUSTRATES COMPUTATION OF MEDIAN

N = Number of cases or individuals; f = frequency or number of cases at each step

Scores on Word Knowledge

<table>
<tr><th></th><th><i>Tallies</i></th><th><i>Frequency (f)</i></th></tr>
<tr><td>100</td><td>|</td><td>1</td></tr>
<tr><td>95</td><td>||||</td><td>4</td></tr>
<tr><td>90</td><td>||||</td><td>4</td></tr>
<tr><td>85</td><td>𝍸||</td><td>7</td></tr>
<tr><td>80</td><td>|||</td><td>3</td></tr>
<tr><td>75</td><td>||</td><td>2</td></tr>
<tr><td>70</td><td>||</td><td>2</td></tr>
<tr><td>65</td><td>|</td><td>1</td></tr>
<tr><td>60</td><td>||</td><td>2</td></tr>
<tr><td>55</td><td>||</td><td>2</td></tr>
<tr><td></td><td></td><td>N 28</td></tr>
</table>

In computing the median take $\frac{1}{2}$ of cases or $\frac{N}{2}$ cases. This becomes $\frac{28}{2}$ or 14, the half sum. Now begin at the bottom and count up until the next frequencies would pass beyond this half sum. We stop at 85 for there are 12 scores below this point. If we should take the 7 frequencies we go beyond the 14. Assuming now that the 7 cases are evenly distributed over this step we say the median is $85 + (\frac{2}{7} \times 5)$. Two-sevenths because we subtract the 12 from the half sum, 14, which leaves us two; then we divide this quantity by the number of frequencies occurring at the next step (here 7). We multiply by 5 because that is the size of the step used. Our median is thus 86.42. This is the mid-point and there are just as many cases above it as below it. You will note that the amount was added to the beginning of the step (here 85).

The median is defined as the mid-point of a table of frequency or of a series of numbers. It is not affected very greatly by extreme cases because extremes count only as one and are not weighted heavily as is the case with the arithmetic average. In discovering the mid-point we must first secure half the cases. For further details see Table XXIV. The median is found to be 86.42. We could then say to our friend "Your score is 8.42 points below the median."

The Arithmetic Average or Mean. The arithmetic average, or better, the mean, is the most familiar measure of central tendency. By adding up all of our original scores and dividing this quantity by the number (28) we may get the mean. But this is a cumbrous procedure and can be much facilitated. See Computation of the Mean (Table XXV). By comparing the median 86.42 with the mean 83.25 we see that the grouping of the cases towards the upper end places the median higher than the mean, for the latter is more affected by the low scores at 55 and 60.

TABLE XXV

Computation of the Mean

Scores on Word Knowledge	*f*	*y′*	*fy′*
100	1	3	3
95	4	2	8
90	4	1	4
85	7		15
80	3	−1	−3
75	2	−2	−4
70	2	−3	−6
65	1	−4	−4
60	2	−5	−10
55	2	−6	−12
N	28		−39

In computing the mean we can multiply the middle of the step by the frequency, add up these products and divide by 28. Thus 102.5 × 1; 97.5 × 4; 92.5 × 4; 87.5 × 7, etc. Add up products and divide by 28. This method is again long and cumbersome. Suppose we take an arbitrary or guessed mean at the median (in step 85) and draw lines to indicate that fact. Now call the deviation from the guessed average in terms of steps, y′. Then going up from 85 to 90 we get one step (column y′); 95 is two steps from 85, 100 is three steps away. All are plus because each is *more* than 85. In the other direction the steps are similarly marked but with a minus sign since each one is *less* than 85 (column y′). Now by multiplying y′ by f we get the total deviations from the average. If we add up the plus fy′s we get 15; if we add the minus fy′s we get minus 39. Then adding algebraically these two quantities, +15 and −39, we get −24. That is, the total deviations in one direction from the average are −24 points more than we would have had if the guessed mean had been the true one. If the guessed mean had been the true one, the sum of the positive fy′s would have equalled the sum of the negative fy′s. By dividing this —24 by 28 (the number of cases) we get the number of steps the guess was wrong. We call this the correction, $Cy = \frac{\Sigma fy'}{N}$. (Where Σ equals sum of, y′ equals deviations, N equals number of cases). Correction $= -\frac{24}{28} = -.85$ of a step. True Mean = 87.5 (always take middle of step in computing mean) $+ (-.85 \times 5)$ which gives us for the mean, 83.25. The −.85 was multiplied by 5 because this is the size of the step.

The Mode. "The mode is the value in a series at which the greatest frequency lies," and is much less important for our purposes than the mean or median. The true mode is rarely computed because of the great amount of labor required. The gross mode may be taken here as 87.5, the middle of the step at which the most frequent measures occur.

MEASURES OF DISPERSION OR SCATTER

Having determined our Median, Mean, or Mode, our measures of central tendency, the next questions we want answered are "How close do the scores cluster around the central tendency? Do they pack in close, or are they scattered far out, or are they medium?" Measures of dispersion have been invented to help us express precisely the answers to these questions. There are several of these measures: The standard deviation (S. D. or σ), the average deviation (A. D.), the median deviation or probable error (P. E.) and the semi-inter-quartile range (Q). We shall introduce the computation of the *standard deviation* (Table XXVI) which is obtained by taking the square root of the sum of the deviations squared, divided by the number of cases. The average deviation or mean deviation is the average of the deviations taken from the mean. The probable error is the median of the deviations taken from the mean. The semi-inter-quartile range, Q, is half of the distance between the first quartile point and the third quartile point. In a normal curve this would be the 25 per cent of the cases on either side of the mean. These measures are all alike in that all measure the amount of scatter of the cases from the measure of central tendency. They differ in the percentage of the number of cases which they include.

TABLE XXVI

ILLUSTRATES THE COMPUTATION OF THE STANDARD DEVIATION

Scores on Word Knowledge	*f*	*y′*	*fy′*	*fy′²*
100	1	3	3	9
95	4	2	8	16
90	4	1	4	4
85	7		15	
80	3	−1	−3	3
75	2	−2	−4	8
70	2	−3	−6	18
65	1	−4	−4	16
60	2	−5	−10	50
55	2	−6	−12	72
N	28		−39	196 = $\Sigma fy'^2$

$$\Sigma fy' = -24$$

$$Cy = -\frac{24}{28} = -.85$$

In computing the standard deviation we use the formula

$$\text{S. D. (Standard Deviation)} = \sqrt{\frac{\Sigma fy'^2}{N} - Cy^2}.$$

The procedure is similar to that of computing the mean, i. e., you arbitrarily assume a mean usually at the median, put in your y′ and fy′ columns, and compute Cy by the same formula, i. e., $Cy = \frac{\Sigma fy'}{N}$. We now proceed to square y′ and multiply the square by f, we thus get column fy'^2.

The quantities in this column are then added up, giving us here 196. Applying our formula, we have: —

$$\text{S. D.} = \sqrt{\frac{196}{28} - (-.85)^2} \times 5 \text{ (size of step)}$$
$$= 2.505 \times 5$$
$$= 12.52$$

If our distribution were normal the Mean plus 12.52 and minus 12.52 would include 68.26 per cent of cases. Our distribution is not normal but approximates it. If we take the Mean, 83.25 and add 12.52 to it we get 95.77; if we subtract it from the Mean we get 70.73. Now between scores 70.73 and 95.77 there are 19 cases, or 67.8 per cent, as compared with 68.26 per cent in a normal curve.

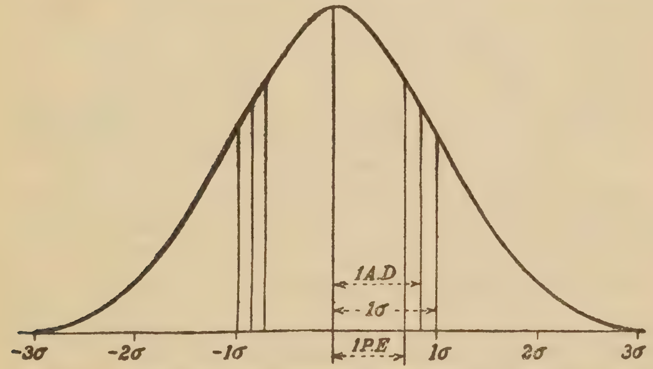

Fig. 28. Shows relations between measures of dispersion in the normal curve. P. E. = .6745σ; A. D. = .7979σ. Included under curve within ± 1σ is 68.26 per cent of cases; ± 1 P. E., 50 per cent of the cases; ± 1 A. D. 57.5 per cent of cases. The probable error in a normal distribution is the same as Q.

Note that the above is a normal curve, by which is meant a curve of a symmetrical shape (Figure 28) and having certain properties. One of these properties is the constant relation between these various measures of dispersion. For example, the P. E. = .6745 S. D.

The other relations are indicated in the graph.

When a large number of individuals are measured in any mental or physical trait there is a tendency for these scores when graphed to approximate the normal curve.

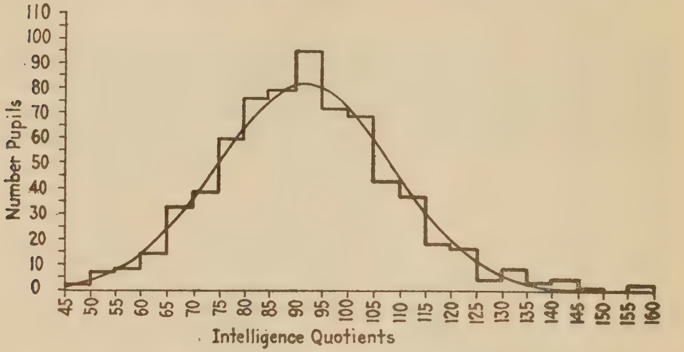

FIG. 29.—Intelligence quotients of 688 pupils on National Intelligence Test. Scores on the first tests. Shows how closely actual data fit the theoretical curve. This latter was calculated by first using the following formula to find the highest ordinate $y_o = \frac{n}{\sigma\sqrt{2\pi}}$; and second, by multiplying this number by the quantities in a normal probability curve table. Mean is 91.77.

This curve is the shape data take when graphed, if a large number of small causes act independently. Practically all measured traits approximate this curve if enough individuals are chosen from representative individuals, i. e., if a random sampling is made. Only one illustration will be presented (Figure 29). Note how closely these data approach the normal curve.

A rather interesting point about this curve is that the average is more than a step below normal (100 in the case of the I.Q.) and yet the distribution approximates so very closely a normal curve. It is apparent, then, first that whenever a mental trait is measured in a large number of individuals and the results graphed the result is a close approximation to the normal curve, that as a consequence of the foregoing the closeness to which a graph approximates a normal curve may be used as a criterion of the random sampling of the cases considered. If there were a piling up of cases at either end or if there were any other of the various irregularities in the graphed data, this might be an indication that there was acting some unaccounted for factor. It would at least be a danger sign that the particular scores producing the irregularity were in need of further investigation.

Let us look back a minute on what we have done thus far. We found scores irregularly arranged, and have arranged them regularly in a table of frequency or table of distribution. We have computed three measures of central tendency (Mean, Median, and Mode). Each of these helped us to give a more complete picture both of individual scores and of the class as a whole. Furthermore, we have introduced measures of scatter or dispersion, measures to determine how closely around the central tendency the scores cluster. These we have listed as the standard deviation, (S. D. or σ), average deviation (A. D.), median deviation (P. E.), and the semi-inter-quartile range (Q). Just as the former are measures of different phases of the central tendency so the latter are measures of different degrees of dispersion. In general, the greater the scatter, the larger is the measure of dispersion. Let us take three cases in which the mean is the same but each case differing from the others by a difference in the amount of dispersion. This is a sixth grade class tested in addition by the Courtis Tests.

1. Case 1. Mean Score 10 S. D. 2
2. Case 2. Mean Score 10 S. D. 4
3. Case 3. Mean Score 10 S. D. 6

In Case 1 the grouping would be homogeneous. The children would be teachable because they, being closely grouped around the mean, would be similar. In Case 2 there would be such scattering among the members in the class that many of the children should be advanced and others demoted because of these great differences. In the third case the scatter would be so large that the class would be in a hopeless condition for purposes of instruction. Some would be so poor that they really shouldn't be in school while those at the upper end would be sufficiently advanced for high school. Instead of saying that "I simply can't teach these children arithmetic because some of them know all about the lesson before I begin while others will never learn" we say more scientifically and understandingly, "This class has a mean of 10 and a dispersion of four. The range is from two examples done in eight minutes to fifteen done in the same length of time."

But what of our subject with a score of 78? Can we not now give him a still more complete account of himself? "In summary," we might say to him, "your score of 78 may be compared with the mean of the group (83.25), the median (86.42), and the mode (87.5). You are 5.25 points below the mean; 8.42 points below the median; and 9.5 points below the mode. Furthermore, we can divide your difference from the mean (5.25) by the standard deviation of the group (12.52) and give you your score in a standard way. You are .41 sigma (or S. D. units) below the mean. And finally 19 out of 28 were above you and 7 below you while one student scored about the same as you did."

This use of the standard deviation to measure the distance of individuals from the mean or median is one of the most useful applications of it. Suppose a student comes to the university with a grade of 90. What does this mean?

We simply cannot tell because in his school the grades might be high or low, the teachers might have easy or hard standards of grading. But if we could have the grades of all the high school pupils and then calculate the standard deviation for the whole group it would be possible to get a more accurate statement about the individual concerned. We would now subtract his score from the average of his class and divide the difference by the standard deviation. This would give a standard deviation score which might be logically compared with similar scores from other groups with some degree of assurance that the quantities compared were the same type of thing. If we should give this a name we could call it a *standard score*. The formula for it would be Standard score $= \frac{X - Mx}{\sigma_x}$, where X is a certain individual's score; Mx is the mean of this group, and σ_x is the standard deviation. It is important to understand these standard scores in learning the facts about the Coefficient of Correlation.

THE COEFFICIENT OF CORRELATION

In correlation work each individual usually has two measures instead of one.[1] The problem is always to find the relation, the coefficient of correlation, between these two traits. Suppose that each of the pupils occurring in the problem discussed in the first part of this chapter instead of having one measure should have two, i. e., a score in word knowledge and a score on the Miller Mental Alertness Test so that the scores now ran as follows:

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[1] This is generally true. There are cases, though, when comparisons may be made between two closely related individuals in the same trait such as the correlation between sibs or twins in intelligence.

Word Knowledge	*Miller*	*Word Knowledge*	*Miller*
92	89	82	103
88	86	78	62
97	114	64	76
95	104	68	62
100	117	97	109
58	58	95	95
90	114	86	69
94	105	85	78
72	82	85	96
91	76	89	104
83	102	77	78
88	92	61	64
83	65	74	82
87	78	59	58

If we attempt to compare these scores as they stand we cannot get very far. We are able by inspection to note that the individuals who score high on word knowledge score rather high on the Miller Test. For example, the person who scores 100 on the word knowledge test scores 117 on the Miller, and the person who scored 59 (the last one) on word knowledge scored 58 on Miller but when it comes to the intermediate cases one can get no certainty of relation. Now the coefficient of correlation is a pure number which expresses the average degree of relationship existing between these two traits in these 28 individuals. It makes much of the standard deviation in its most accurate computation.

The most commonly used method is that of Pearson. The formula derived by Pearson is $r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$, where Σ is equal to "the sum of," x is the deviation of any score from the mean of one trait, while y is the deviation from the mean in the other trait, N is the number of cases, σ_x is the standard deviation of one trait, and σ_y is the standard deviation in the other trait. You will notice immediately that you are already acquainted with all the entities and could compute the coefficient of correlation from the formula. For instance, you could compute the mean and S. D. of the word knowledge as has already been done, then the mean and S. D. of the Miller Test. When you have the S. D.'s calculated the denominator is finished simply by multiplying these two S. D.'s together and their product by N (here 28). The new computation would be in the numerator but with the two means before us we could subtract each score from the appropriate mean, multiply these deviations together (indicated by xy) and add them up (indicated by Σ). The sum of these products would be the numerator. Divide the numerator by the denominator and the problem is solved. One point of importance is that each individual's score is subtracted from the average and *divided by the standard deviation.* In brief each individual's score is made a standard score in one trait and then multiplied by his standard score in the other.

Table shows the computation of the Coefficient of Correlation by the long method.

TABLE XXVII

Computation of the Coefficient of Correlation by the Long Method

Word Knowledge X	*Miller* Y	x	y	x^2	y^2	xy
92	89	9	3	81	9	27
88	86	5	0	25	0	0
97	114	14	28	196	784	392
95	104	12	18	144	324	216
100	117	17	31	289	961	527
58	58	−25	−28	625	784	700
90	114	7	28	49	784	196
94	105	11	19	121	361	209
72	82	−11	−4	121	16	44
91	76	8	−10	64	100	−80
83	102	0	16	0	256	0
88	92	5	6	25	36	30
83	65	0	−21	0	441	0
87	78	4	−8	16	64	−32
82	103	−1	17	1	289	−17
78	62	−5	−24	25	576	120
64	76	−19	−10	361	100	190
68	62	−15	−24	225	576	360
97	109	14	23	196	529	322
95	95	12	9	144	81	108
86	69	3	−17	9	289	−51
85	78	2	−8	4	64	−16
85	96	2	10	4	100	20
89	104	6	18	36	324	108
77	78	−6	−8	36	64	48
61	64	−22	−22	484	484	484
74	82	−9	−4	81	16	36
59	58	−24	−28	576	784	672
Sum 2318	2418			$\Sigma x^2 =$	$\Sigma y^2 =$	$\Sigma xy =$
Mean 83	86			3938	9196	4613

The nearest whole numbers are taken as the means in order to save time.

$$\Sigma x^2 = 3938,\ \Sigma y^2 = 9196 \quad \Sigma xy = +4809 \quad -196$$

$$\Sigma xy = 4613$$

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

$$r = \frac{4613}{28\sqrt{\frac{3938}{28}}\sqrt{\frac{9196}{28}}}\,[1]$$

Then,

$$r = \frac{4613}{\sqrt{3938}\sqrt{9196}}$$

$$r = .766$$

This method consumes an enormous amount of time if the deviations are taken from the true average. It also has the disadvantage of not giving any clue to the answer such as the graphical representation will do. Table XXVIII shows the graphical method of solution. It uses the knowledge gained from the computation of the standard deviation. We use here the guessed or arbitrary mean and correct for the guess.

Computation of the Coefficient of Correlation by the Graphical Method. First find the highest and lowest scores on the word knowledge test and on the Miller Test. On word knowledge the highest is 100; the lowest 59; on the Miller the highest is 117, the lowest 58. We then arrange the scores from highest to lowest in one case; and from lowest to highest in the other. We thus have in Table XXVIII the Miller scores running along the top of the graph in steps of five: 58, 63, 68, and the word knowledge going down the page 100, 95, 90, 85, etc. Referring to page 271 we may plot those scores upon the graph. The first pair of scores is 92 on word knowledge and 89 on Miller's Mental Alertness Test. We run down from 100 to 95 to 90 and stop at 90 because 90 reaches up to 94.99, we then proceed across the page until this row crosses the 88 column (88 because 89 falls at this step). At the juncture of these two, we place a stroke. The stroke then represents the 92 on word knowledge and the 89 on Miller. Let us take the second pair (88–86). We run down the word knowledge scores until we arrive at 85 (for 88 falls at this step) then across to 83 on Miller. At the juncture of the 85 row on word knowledge and of the 83 column on mental alertness we make a stroke. And thus we proceed in all 28 pairs, placing the strokes at the juncture of that row and that column which the scores for each member of the pair indicate. When all 28 scores are thus graphically represented we have a "scatter diagram." From such a diagram some matters concerning the correlation may be observed. In so far as the cases tend to arrange themselves near or upon a line running from the lower left-hand corner to the upper right-hand corner and making an angle of 45 degrees with the point where the averages cross, just so far is perfect positive correlation attained. In so far as the cases seemed scattered at random over the graph just so far does the correlation approach zero. If the scores tend to arrange themselves upon or near a line running from the upper left-hand quadrant to the lower right-hand quadrant is the coefficient negative. A comparison of the graphical representation with the attained coefficient is always greatly to be desired. Now let us proceed with the computation.

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[1] By bringing the two 28's from under the radical they cancel the 28 on the outside.

Once the scores are placed upon the graph we proceed immediately as follows:

1. Add up the frequencies in each row and place them under the column marked "f."

2. Guess a mean. Ordinarily the median is a convenient point to guess. Then proceed with y', fy', fy'^2 just as in computing the standard deviation. C_y and σ_y are then computed.

3. Proceed in exactly the same way with the columns,

TABLE XXVIII

Showing Computation of Coefficient of Correlation by the Graphical Method

Mental Alertness (Miller)

Word Knowledge	58	63	68	73	78	83	88	93	98	103	108	113	f	y'	fy'	fy'^2	$x'y'$	
100		(−)							(+)			I$^{(18)}$	1	3	3	9	18	
95								I$^{(4)}$		I$^{(8)}$	I$^{(10)}$	I$^{(12)}$	4	2	8	16	34	
90				I$^{(2)}$			I$^{(1)}$			I$^{(4)}$		I$^{(6)}$	4	1	4	4	9	
85			I		II	I	I	I		I			7		15			
80		I$^{(4)}$							I$^{(3)}$	I$^{(4)}$			3	− 1	− 3	3		−3
75	I$^{(10)}$				I$^{(2)}$								2	− 2	− 4	8	12	
70					II$^{(3)}$								2	− 3	− 6	18	6	
65	I$^{(20)}$												1	− 4	− 4	16	20	
60		I$^{(20)}$		I$^{(10)}$					(−)				2	− 5	− 10	50	30	
55	II$^{(30)}$			(+)									2	− 6	− 12	72	60	
f	4	2	1	2	5	1	2	2	1	4	1	3	28		− 39	196	189	− 3
x'	− 5	− 4	− 3	− 2	− 1		1	2	3	4	5	6						
fx'	− 20	− 8	− 3	− 4	− 5	− 40	2	4	3	16	5	18	48					
fx'^2	100	32	9	8	5		2	8	9	64	25	108						

$\Sigma fy' = -24$

$\Sigma fy'^2 = 196$

$Cy = -.85$

$\sigma y = 2.505$

$\Sigma (f)x'y' = 186$

$\Sigma fx' = 8$

$\Sigma fx'^2 = 370$

$Cx = .28$

$\sigma x = 3.62$

i. e., add up the frequencies in each column and draw them down under "f."

4. Then compute C_x and σ_x just as in Table XXVI.

5. In this case the S. D. of word knowledge is 2.505 times the size of the step; while the S. D. of mental alertness is 3.62 times the size of the step. In computing the *Coefficient of Correlation we omit the size of the step since it would occur in both the numerator and the denominator and would cancel.* It is for this reason that in computing the coefficient of correlation the size of the step may be omitted.

6. The denominator having been computed we proceed to the numerator. From your formula we see that the only new thing is the $\Sigma(f)x'y'$ which now will be computed.

7. Remember (a) that the x' is the distance from the assumed or guessed average, (b) that each stroke must be referred to each of the averages, and (c) that we are interested in products in this connection.

8. Let us begin in the upper right-hand corner with the individual who scored 100 on word knowledge and at the 113 step on mental alertness. If we count the steps to the average lines on mental alertness we shall find six of them; to the average lines for word knowledge we shall find three of them. This individual's $x'y'$ score then is 6×3 or 18 (see the parenthesis above the stroke). This 18 is multiplied by the number of cases occurring in this particular box. Here there is but one so that the $x'y'$ product is 18×1 or 18. In the next row in the upper right-hand corner the first score has the value of four because it is two steps from each average line, the next 8 (four steps from the mental alertness average lines and two from those of word knowledge). In this line there are $x'y'$ products of 4, 8, 10, and 12 which together give 34 (see $x'y'$ column).

9. The determination of the signs of the quadrants, when the scores are arranged from low to high in one set of scores and from high to low in the other, is an easy pro-

cedure, for the quadrants have always the signs which appear in Table XXVIII. But in any case the signs may be determined as follows:

(a) The increasing direction from the average is always plus.

(b) The decreasing direction is always minus.

(c) In the upper right-hand quadrant the upward direction (1) would be plus because the scores are increasing from 85 to 100. The direction to the right is plus, because mental alertness is increasing in this direction from 83 to 113. Now the product of these two plus signs gives plus. (2) In the upper left-hand quadrant the sign is minus because, up is plus as before but to the left is minus since mental alertness decreases in this direction from 83 to 58. Since we are dealing with products, plus times a minus gives minus and so on in the other products.

(d) This method always holds though the arrangement should differ.

We now add up our rows of x′y′ products (column x′y′) paying particular attention to the signs of the products. In this case the sum of the x′y′ products is + 189 and − 3 or a sum of 186. Thus $\Sigma fx'y' = 186$.

10. Using these scores we substitute in our formula, clear fractions, and obtain an answer of .758.

$$r = \frac{\frac{\Sigma(f)x'y'}{N} - C_x C_y}{\sigma_x \sigma_y}$$

$$\frac{\frac{186}{28} - (-.85)(.28)}{3.62 \times 2.505}$$

$$r = .758$$

By the other method the coefficient of .766 was attained, a slight difference which may be due either to our having taken the nearest whole number in the first case or to our having used groups of five in the second, or to both.

THE MEANING OF THE COEFFICIENT

The coefficient of .758 indicates a close degree of resemblance between word knowledge and mental alertness. To remember that perfect correlation is + 1.00, chance correlation is 0, and perfect negative relationship − 1.00 helps a little more in interpretation. Furthermore, Rugg's general principles of r being negligible or indifferent when it is .15 or .20; present but low, from .20–.35; marked, from .35 to .60 and high when above .60 or .70 give us a rough measure of the closeness of relationship. There is no doubt but that there is a general trend for students who score high on one to score high on the other; who score low on one to score low on the other; who score medium on one to score medium on the other. The degree of resemblance or mutual implication is represented by .758. A thorough understanding of this matter requires further study in the field of regression equations, partial correlations, and much experience in the calculation of the coefficient.

Reliability of the Coefficient. Once we have the .758 can we depend upon subsequent calculations between these variables to give us similar results? The reliability of the coefficient depends upon two things:

(a) The size of the coefficient
(b) The number of cases.

The formula for the probable error of the coefficient of correlation is $\text{P. E.}r = \frac{.6745\ (1 - r^2)}{\sqrt{\text{N}}}$. This P. E. gives the limits within which subsequent coefficients are likely to fall. If the r is large the probable error decreases, if small it increases; if r is 1.00 the P. E. is zero. If the number of cases is small the P. E. is large; if they are large it tends to be small. It will also be noticed that since the reliability is a function of the square root of the number of cases to double the reliability the number of cases has to be multiplied by four. Let us illustrate with our coefficient

$$\text{P. E.}_{r} = \frac{.6745\ (1 - .758^2)}{\sqrt{28}} = .054.$$

The coefficient $r = .758$ with a probable error of .054 or as is generally written $r = .758 \pm .054$. We may express this as follows:

The chances are even that on the computation of the coefficient with another group of individuals the coefficient would fall within the range of .704 to .81. The chances are 4.5 to 1 that subsequent coefficients would fall within 2 P. E., i. e., between .650 and .866; the chances are 21 to 1 that these coefficients would fall within the range of 3 P. E.; and 121 to 1 that they would fall within 4 P. E. A practical criterion of a coefficient of correlation is: the *coefficient of correlation should be at least three times, and better four times, the size of its probable error to be accepted as reliable.*

USES OF THE COEFFICIENT OF CORRELATION

The coefficient of correlation has been one of the most widely used statistical devices ever developed. It has been of great value not only in the fields of Psychology and Education but also in the fields of Sociology and Economics.

a. *Prognosis.* The prediction of human action has always been one of the aims of a science of Education. Just how well does a test or school mark prophesy what an individual will subsequently do? If he makes a good grade in the elementary school will he also do well in high school? If he does well in high school will he also do well in college? One of the earlier studies (Kelley's) used the marks received in the elementary school and those received in high school. The correlation between these two sets of grades was computed. It was discovered that the high school marks of an individual could be anticipated fairly well from marks received in a grade as low as the fourth. When we consider the instability of marks received in the fourth grade as well as those received in high school such a close resemblance is rather remarkable. Another student (Dearborn) computed the coefficient of correlation between the marks received in eight Wisconsin high schools and those received in the University of Wisconsin. He found a very high resemblance ($r = .80$) existing between these two sets of measures. Mental tests and entrance examinations have also been correlated with marks. Thus the question, as to whether entrance examinations of the usual type, mental examinations through tests, or high school marks are better for prognosis has been intelligently discussed by computing the r's in each case with subsequent collegiate marks. The ordinary entrance examination has thus proved to be much worse than the other two in foretelling how well an entrant will do. Indeed, Thorndike discovered that there was a higher correlation between the school marks of a student and his brother than there was between a student's marks and *his own* entrance examinations. This coefficient stating in one figure a comparison between two variables permits definite comparisons. In the army, there arose a question as to whether the Army Alpha Tests were of any value for foretelling whether a draftee would be good officer material, or not. Prophecy was made by means of the tests and later correlations were computed with military success. The results (coefficients ranging between .50 and .70 between the tests and the officers' ratings of their men) proved conclusively that this test was prophetic of subsequent military success. In comparing tests as to which is best for purposes of prophecy two or three tests may be made and then correlations computed with some criterion or other, say school marks, and a definite conclusion regarding the best test to be used is arrived at.

b. *Reliability.* The coefficient of correlation has been used very broadly to discover whether or not a test measures on two successive occasions the same type of thing. In brief, in taking the same test a second time individuals may vary in their scores. The coefficient informs us immediately and precisely to what extent a test gives the same results on two successive applications to the same group of children. It has thus been determined that the Binet-Simon (see next chapter) Tests are among the most reliable instruments of measurement of mental traits that we have, that the *r* between two successive administrations of these tests gives a coefficient of about .90. The reliability of group tests ranges from .75 to .85. If a test is not reliable, if it does not agree with itself, it cannot be of value for purposes of measurement. Are tests as reliable as school marks obtained in successive semesters? The best tests are much more reliable than school marks. The coefficient between school marks obtained in successive semesters ranges from .60 to .75; the reliability of mental tests from .75 to .85. The reliability of educational and vocational tests are thus definitely known.

c. *Validity.* Just what does a test measure? A test's worth and value are known by its correlations. As soon as there appears a new test on the horizon the question immediately arises as to what it actually tests, not what it claims to test, and this question is answered by the magnitudes of the coefficients with various criteria. Thus in one investigation in a high school the coefficients of the Otis Tests of Intelligence were found to be with school marks .45; with Stanford-Binet mental age .66; with teachers' estimates of intelligence .73; with age – .41; with an alphabet learning test .23. The Army Alpha Tests correlated .48 with school marks; .69 with Stanford-Binet mental age; .61 with teachers' estimates of intelligence; – .28 with age; and .21 with a learning test. Furthermore, correlations of Otis and Army Alpha with marks received in four high school subjects were computed with these results:

Otis with English .47	Alpha with English .47
Otis with Mathematics .43	Alpha with Mathematics .51
Otis with General Science .50	Alpha with General Science .46
Otis with History .26	Alpha with History .32

Every worth-while test has both its reliability and validity definitely expressed in coefficients of correlation.

d. *Other Uses of the Coefficient of Correlation.* In the construction of tests there is always the question of whether each element of the test is related to other elements or to the test as a whole, and as to whether each element is related to the criterion chosen. In the construction of the National Intelligence Tests, e. g., each element of the test was correlated with scores on the Thorndike-McCall Reading Test as well as with each other. The desire being to get a group of tests which were loosely related to each other and closely related to some known measure of intelligence. The coefficient has been further used in discovering tests that would predict success in typewriting and other vocations; in discovering whether desirable mental traits were correlated or whether an individual possessed compensatory traits, indicated by negative correlations between desirable traits (none found), as to whether one test could be found which might indicate the presence of a whole constellation of traits, and finally in throwing light on the question of the organization of intellect. In seeking a solution to this last problem some have held that resemblance between traits is due to the presence of two factors: a general factor of intelligence, Spearman's *g* factor, which is present in varying degrees in two correlated traits producing varying degrees of correlation in proportion to the amount of the factor present and to the presence of specific factors. On the other hand, others (led by Thorndike) hold that the intellect is nothing more than a series of connections between situations and responses. These connections vary in strength. Furthermore, one trait is related to another trait because the two traits have certain elements common to them both, i. e., "identical elements." The answer to this question has been sought through the long series of correlations (such as those of Burt, Thomson, and Spearman) but the solution of the problem is not yet. Sufficient evidence has now been introduced to convince the student of the enormous importance of the knowledge of statistics in *Educational Psychology* and more particularly of the significance and meaning of the coefficient of correlation.

SUMMARY

A knowledge of statistics is invaluable to the student of *Educational Psychology.* One cannot even read the literature in the field of individual differences without a knowledge of the elementary facts set forth in this chapter. For the student who intends taking advanced work in this field one or more courses in statistics is essential.

Scores from tests of various kinds come in without any arrangement and it becomes necessary to order them in such a manner that they may be intelligently scrutinized. The table of frequency is the first step in this ordering process. From this table one can observe the scattering of the cases, the gaps, the points around which scores cluster. It is the one most important aid in interpreting the results of the measurements of a single trait. Measures of central tendency (Mean, Median, Mode) give further important information about the general trend of the whole group. They are the most typical and most significant single measures. Measures of dispersion (S. D., A. D., P. E., and Q) make definite and precise what was apparent in the table of distribution or frequency. They state quantitatively the amount of clustering of the scores around the central tendency. The different measures of dispersion include differing percentages of cases within their limits but all measure essentially the same sort of thing.

The coefficient of correlation is useful whenever each member of a group of individuals has been measured on two or more traits. It expresses in one figure the average degree of resemblance or mutual implication between the two traits. This measure has been abundantly useful in expressing the reliability and validity of measures, the relation between mental and physical traits, and in foretelling the probable standing on one test from the scores of another. Its reliability depends upon the number of cases included and the closeness of the correlation.

QUESTIONS AND EXERCISES

1. The following scores were received by university students on a test of mental alertness (Army Alpha): 128, 146, 96, 169, 174, 181, 152, 100, 91, 130, 141, 146, 175, 113, 168, 133, 171, 154, 132, 157, 98, 132, 88, 172, 146, 118, 121, 153. Use steps of five. Make a table of distribution and compute the Mean and Median. Which is higher? Why?
2. Compute the standard deviation for the group as a whole and the standard scores for 181, 152, 100, 91, 88, and 141.
3. Just what does the S. D. measure?
4. If you had space for just one measure of this distribution, which would you report?
5. Three classes which were measured in computation in arithmetic made average scores as follows: 15, 15.8, 15.9 and had standard deviations as follows: 3, 5, and 7 respectively, which would be easier to teach? Why?
6. A fourth grade class was given the National Intelligence Tests, Scale A. The first of these tests is composed

of arithmetic problems; the fourth, of pairs of words, some pairs being similar and others, opposite. These two tests are ordinarily called arithmetic reasoning and opposites.

The scores were:

Arithmetic Reasoning	*Opposites*	*Arithmetic Reasoning*	*Opposites*
10	14	8	8
10	3	8	12
10	15	14	24
8	12	14	22
10	17	14	17
12	11	18	19
6	8	12	8
10	16	10	14
12	14	6	11
18	21	14	0
8	9	2	9
10	1	16	14
16	12	2	2
12	11	10	4
6	0	12	16
10	13	10	8
14	6	10	15
16	12	10	5

a. Compute the coefficient of correlation the long way.

b. Check the work by using the graphical method of guessed average with corrections.

7. What does the coefficient of correlation obtained mean?
8. Compute the probable error of r. Is the coefficient a reliable one?
9. On what two facts does this reliability depend? Is the meaning of "reliability" here the same as it is when we say that "The Coefficient of Correlation computed from data derived from the consecutive administration of two tests shows the test to be highly reliable"? What is the difference?

10. Cite four or five uses of the coefficient of correlation. Look up at least four cases of the use of this coefficient and report to class.

REFERENCES

I. Good Textbooks on Statistics

A. For Beginners

Garrett, H. E. *Statistics in Psychology and Education*, 1926.
Odell, C. W. *Educational Statistics*, 1925.
Otis, A. O. *Statistical Method in Educational Measurement*, 1925.
Rugg, H. O. *Statistical Methods Applied to Education*, 1917.
Thurstone, L. L. *The Fundamentals of Statistics*, 1925.

B. For More Advanced Students

Brown, William, and Thomson, G. H. *Essentials of Mental Measurement*, 1921.
Kelley, T. L. *Statistical Method*, 1923.
Yule, G. U. *Introduction to the Theory of Statistics*, 1916.

II. Illustrations of Good Usage of the Correlation Method

Burt, C. "Experimental Tests of General Intelligence," *British Journal of Psychology*, 1909, Vol. III, pp. 94–177.
Freeman, F. N. *Mental Tests*, Chap. III, 1926.
Kelley, T. L. *Educational Guidance*, 1914.
Pintner, Rudolph. *Intelligence Testing*, pp. 220, 255–257, 267–268, 272, 276, 297, 378, 388–390, 1923.
Simpson, B. R. *Correlation of Mental Abilities*, 1912.
Starch, Daniel. *Educational Psychology*, Chap. IV, 1927.

CHAPTER X

INDIVIDUAL DIFFERENCES AND THEIR CAUSES

Individuals differ widely among themselves in any conceivable trait. This is no new fact, of course, but modern methods of precision in the measurement of mental traits have made us sensitive to the enormity of these differ-

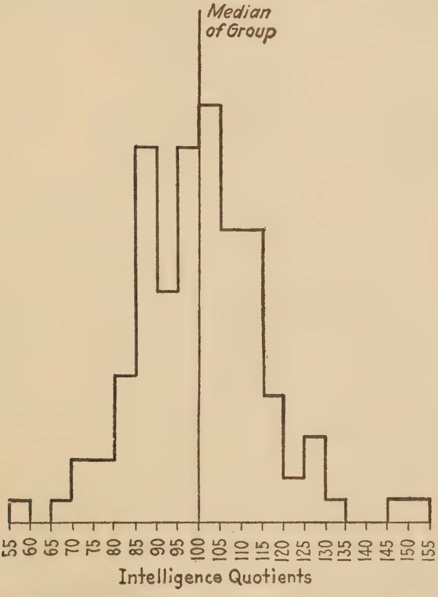

FIG. 30.—Variation in I. Q.'s in 123 first grade pupils as tested on the Pintner-Cunningham Test. Median is 99.86.

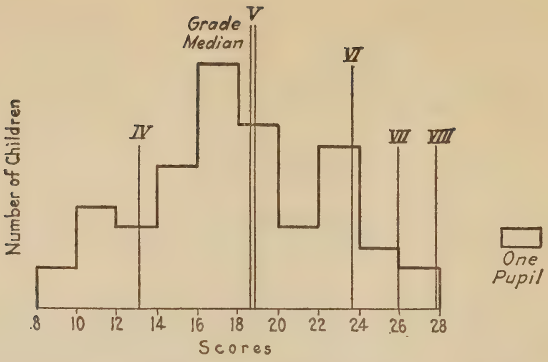

FIG. 31.—Scores of children in Grade IV in Woody-McCall Mixed Fundamentals. Grade standards (Roman numerals) also entered.

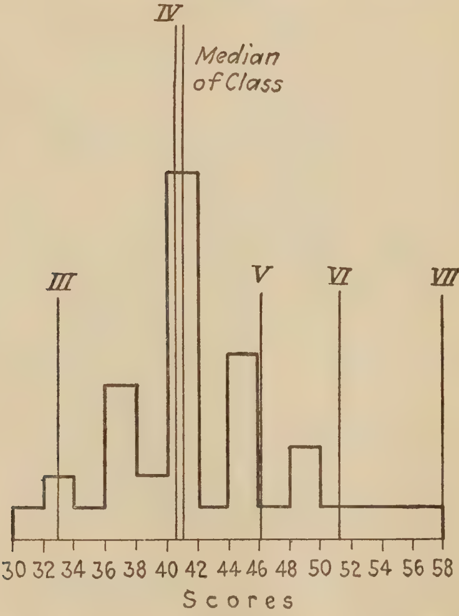

FIG. 32.—The variations in reading of a single beginning fifth grade class. Points are T-scores on the Thorndike-McCall Reading Test. Roman numerals represent grades.

ences and have given us precise measures of them. In short, they have objectified and quantified our thinking upon these matters until to-day one of the most startling revelations of modern psychology is the tremendous differences existing among individuals grouped on account of age or for some other reason. Illustrations taken from all levels of development are now presented.

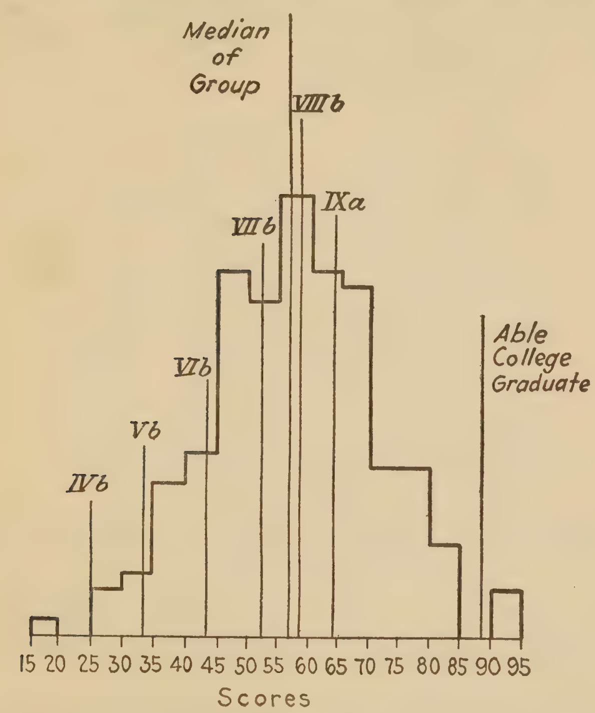

FIG. 33.—Scores of 183 children in five different eighth grades on Thorndike's Test of Word Knowledge. Median score is 57.6.

Figure 30 shows the I.Q. variations in 123 children from the first grades of a single city. It will be noted that the median is about as near normal as could be expected and yet the range is very large. On the one hand we find children definitely feeble-minded; on the other, children from the highest levels of mental capacity, and yet each child comes to school expecting to be treated just as nearly like every other one as possible. Some children in this grade are bright enough to do third and fourth grade work with ease.

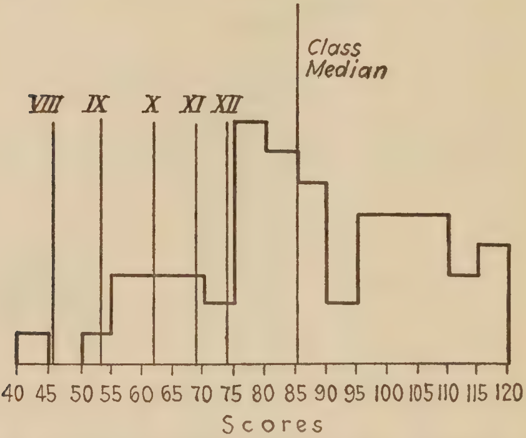

Fig. 34.—Showing distribution of ordinary university class in Miller Mental Ability Test.

Almost as large differences appear in arithmetic in the fourth grade.

Figure 32 shows a similar situation in a fifth grade in which a test of reading had been given. Here the scores vary from third grade level to that of the seventh.

In word knowledge (Figure 33) we have another capital illustration with differences as great as those between the fourth grade and able college graduates, represented in the freshman class of a high school. It is the provision for just such differences as these which will be discussed in the next chapter.

Finally, in Figures 34 and 35, we have similar illustrations from the college field. In no case has there been any special effort to measure classes that had an unusually large range. The illustrations are random samplings of measurements in general and represent omnipresent conditions.

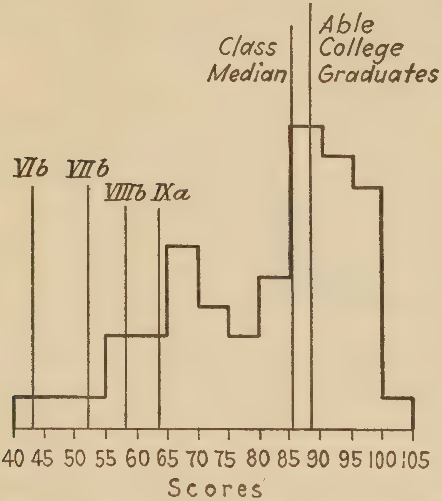

Fig. 35.—Showing wide distribution of students in Thorndike's Test of Word Knowledge in ordinary university class. Roman numerals are grade medians.

Causes of Individual Differences

Since such differences are so apparent the present question arises immediately as to the cause of these large differences in groups.

Five causes of these differences will be discussed:

(1) Differences due to sex
(2) Differences due to race

(3) Differences due to maturity
(4) Differences due to near ancestry or family
(5) Differences due to environment.[1]

1. *Differences Due to Sex.* The question raised in this section concerns the differences among individuals due to the mere fact of being born a boy or a girl. Are there any distinctive differences in mental traits which can be directly attributed to being a member of one sex or the other? In short, are there any traits whose inheritance are sex-linked, i. e., that appear only in one sex or the other? In their searches geneticists have found at least one trait which approaches this condition. Color-blindness appears to be transmitted from the father through his daughter in whom the trait is recessive, to her son. But, in general, there are no mental qualities unique either to male or female.

If there are differences in mental traits they consist in varying degrees or amounts of traits essentially similar. Such questions as the following might be asked: Do girls use language more effectively than boys? Do they react as quickly to a stimulus? Do they learn French as quickly? Do they like books of adventure as well as boys? In attempting to answer questions concerning the amount of these traits in similar groups the method of expressing the difference between them is important. One can say, for example, that the median attainment of boys in spelling was fifteen words, of girls seventeen, but this does not call attention to the number of boys who exceed the median of the girls and there are perhaps some in this case who do. Probably the most understandable method is that of the percentage of overlapping. In this case we calculate the percentage of one group that reaches or exceeds the median of the next group. We might say in this case that 40 per cent of the boys reach or exceed the median of the girls. This would indicate that girls were better but would also call attention to the essential similarities of the two groups. This method is valuable only when the groups to be compared resemble each other rather closely. It is valueless when zero per cent of one group reaches or exceeds the median in the other for, in this case, the groups might be infinitely distant from each other or the best in one might almost reach the median of the other.

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[1] See Thorndike. *Educational Psychology*, Vol. III.

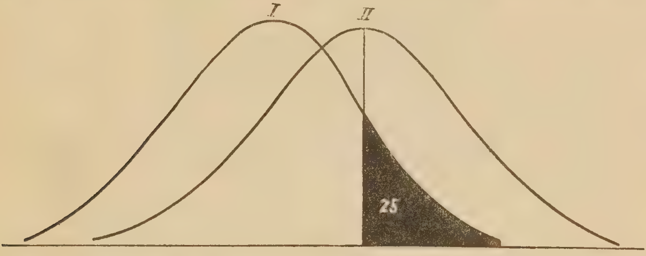

Fig. 36.—Shows the percentage of Group I reaching or exceeding the median of Group II. The shaded portion (here about 25 per cent of Group I) represents the cases in Group I who are as good as or better than the median of Group II.

Fig. 36 is an illustration in which about 25 per cent of one group reaches or exceeds the median of the other. If the groups were equivalent 50 per cent of Group I would reach or exceed the median instead of 25 per cent. Rarely ever do we find a group of boys differing from a corresponding group of girls as much as is indicated in this graph.

Measurements of Differences. One is immediately conscious on approaching this problem of the enormous difficulties incident to getting similar groups of boys and girls. Thus one of the earlier investigators (Helen Thompson Woolley) considered her task well done when she tested twenty-five men and twenty-five women selected from the upper classmen of a midwestern university; while another has used data assembled from normal schools and yet another from high school, etc. From a large number of measured traits available we shall select a few which show the largest differences.

Percentage of males reaching or exceeding the median performance of females:

I	*In traits precisely measured*	
	Motor ability	72
	Reaction time	68
	Tapping	67
	Arithmetic reasoning	60
	Discrimination of colors	39
	Quality of handwriting	39
	Memory of words	40
	Memory for syllables	32
II	*In school subjects (High School)*	
	English	34
	French	32
	Latin	40
	Physics	61
	Chemistry	62

Boys are somewhat better in quickness of reaction time, in arithmetic reasoning, in school marks such as physics and chemistry. Girls are better in memory and in general language capacity. Probably the greatest differences appear in emotional traits represented by the types of reading which they choose.

The questions mentioned in Chapter I concerning preferences for books have now been asked more than five thousand boys and girls with results so similar that the results from only one investigation will be given here:

TABLE XXIX

Percentage of Boys and Girls Choosing Books of Adventure or of Fiction. They Wrote Down the Names of Five Books They Liked very Much.

Ages		*9–11*	*12–13*	*14–16*	*17–18*
Number	B.	59	253	846	283
	G.	87	336	1195	414
Fiction	B.	4	6	18	30
	G.	15	33	45	58
Adventure	B.	56	64	59	49
	G.	12	17	18	22

Table XXIX and Figure 37 make clear the rather remarkable differences between boys and girls in their preferences for books. At years 9–11, for example, we find only 4 per cent of boys liking books classified as adult fiction; while 15 per cent of the girls make similar choices. If we then turn to adventure we find during these same ages 56 per cent of boys and only 12 per cent of girls definitely liking these types of books. What is true of ages 9–11 is also true of ages 12–13, 14–16, and 17–18 except that the differences are not quite so great in the upper ages. Furthermore, the most popular books for boys are *The Call of the Wild*, *Boy Scout Series*, and *Treasure Island;* while girls like best *Little Women*, *Girl of the Limberlost*, and *Pollyanna.*

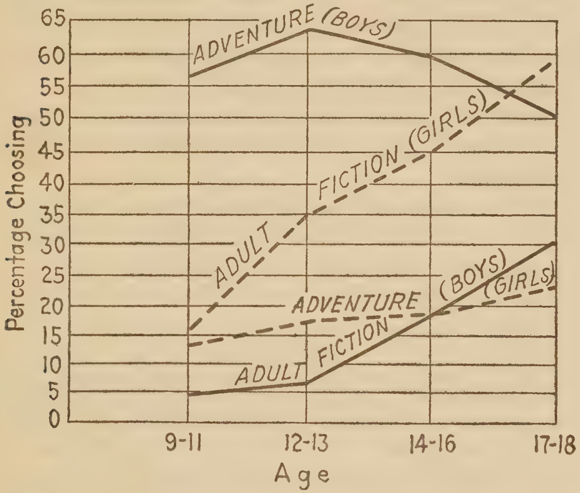

FIG. 37.—The interest of boys and girls in adventure and in adult fiction. Investigation by means of the questionnaire. (Jordan, 1921.)

In investigations in children's libraries in and around

New York City results similar to those of the questionnaire were discovered. In this investigation as far as could be determined by a combination of several sorts of evidence, boys liked best (a) books concerned with war and scouting, (b) those treating of school and sports, (c) those treating of boy scouts, and (d) those concerned with other types of strenuous adventure. These most interesting books differed widely from those liked by girls for they read with greatest eagerness books concerned with (a) home, (b) home and school, (c) fairy stories, and (d) love stories. There is no question but that these are important differences between boys and girls in their preferences for both books and magazines.

In general, measurement shows that, in the majority of traits, men and boys on the one hand and women and girls on the other are equal. The differences are so small that chance throws the majority now on one side now on that. Girls do seem to be superior in memory and quality of handwriting; while boys are superior in arithmetic reasoning and general motor ability. Girls do better in language; boys in science. There are also differences in interest in books and magazines. Furthermore, investigation shows that three times as many boys as girls have speech defects, and three times as many boys as girls are color-blind. Finally, boys seem a little less inclined to take a suggestion than do girls. One instance of this occurred in an experiment (Book and Norvell) in which the control group (college men and women) was instructed to fold the papers on which their scores were written so that they could not see their scores and also *not to think about the score they had just made.* In carrying out this last request the women were more successful than the men for they reported that they carried out the instructions not to remember in *75 per cent* of the cases while the men carried out the instructions in only *18 per cent* of the cases.

If, then, there are no very great differences in mental traits why have there been only 32 women out of the 1000 most distinguished persons of the civilized world? How have the men been able to attain such an overwhelming majority of distinguished positions? In answering these questions some have resorted to the argument of greater variability of the men.

If men were more variable than women then there would be a small percentage of men at each extreme of the curve beyond the limits of females, i. e., there would be among the men more feeble-minded and more geniuses. The following Graph indicates what occurs when two groups are equal in central tendency but differing in variability:

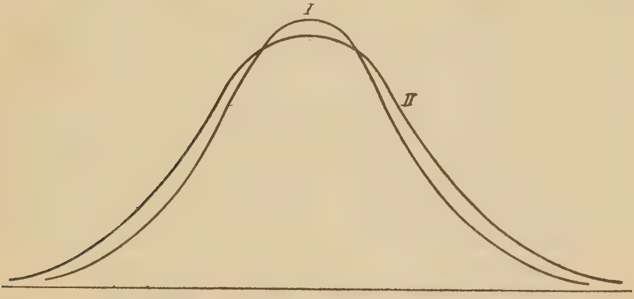

FIG. 38.—Illustrates the differences between two groups with the same mean but with unequal amounts of dispersion.

Suppose in Figure 38, line I represented the attainment of girls, and line II represented that of boys in intelligence, let us say. Then a few boys would be more stupid than the most stupid girl and contrariwise, a few would be more intelligent than the most intelligent girl. If this were true it would account for the large discrepancy between men and women in the proportion of geniuses. But is it true?

In the first place, for a long time statistics have shown a larger percentage of boys and men in our institutions for feeble-minded and this had been accepted as showing that there were a larger number of feeble-minded males. But even these facts have recently been called into question by one investigator (Leta S. Hollingworth) in showing that the girls admitted to institutions are more stupid than boys. This indicates that feeble-minded girls who frequently are kept at home performing the simpler household tasks escape detection while their brothers venturing outside of the home to earn a living are caught and sent to the institutions. It thus appears that the influence based on hospital statistics in regard to the number of feeble-minded men may be erroneous.

On the other hand, another student (Terman) in attempting to discover the thousand most gifted children discovered 121 boys to 100 girls, a fact which could not be explained away by reference to the data he had. But even here, we find in the data collected by the same investigator for the extremely high I.Q.'s the percentages as follows:

	160 or above	*170 or above*	*180 or above*	*190 or above*	
Boys	18.5	6.2	2.6	0.0	
Girls	16.5	7.2	2.0	1.0	(highest three)

Which facts indicate that girls hold their own in the highest levels of intelligence. This ratio of 121 boys to 100 girls is the more interesting since this author's earlier studies in standardizing the Stanford-Revision of the Binet-Simon Intelligence Tests seem to show that there were no reliable differences between boys and girls of the same age. Moreover, Pyle and Trabue had found no greater variation among boys than among girls. More recently, Pressey in two investigations found boys more variable than girls and in one, found no difference between them. And thus the matter stands with no definite conclusions as to the greater or lesser variability of boys and girls or of men and women.

For purposes of summary there have been prepared in parallel columns some of the interesting differences which have fairly reliable studies in their favor:

Female	Male
I. Greater ability to memorize.	I. Greater motor ability: (a) quicker reaction time (b) tapping (faster) (c) thrusting at target (more accurate) (d) lifting weights (better discrimination) (e) stronger grip.
II. Quality of handwriting, better on the average.	II. Greater ingenuity in arithmetic reasoning and in tests involving ingenuity.
III. Sensibility is more acute in the realm of sensory discrimination such as pain, taste, and smell.	III. Greater resistance to size-weight illusion.
IV. Greater linguistic ability: (a) better in languages (b) better on analogies test (c) better on word building.	IV. Better in physics and chemistry.
V. Much better in mirror drawing.	V. Three times as many speech defects.
VI. Take suggestions more easily and carry them out. Less resistive to suggestion.	VI. Three times as many color-blind as girls.
VII. Girls more interested in: (a) love stories (b) fairy stories (c) stories of home and school. Probably daydream more. Have more “crushes” on each other than boys.	VII. More interested in: (a) stories of adventure (b) magazines of science (c) war and scouting (d) stories of sport (e) stories about Boy Scouts.

Differences Due to Race. Race undoubtedly plays a small part, in some cases perhaps a considerable part, in producing differences among individuals. Just what these contributions are and their amount has not been determined in any single case. It is so difficult to know just what are pure human stocks and to distinguish between inherited nature and acquired nature that the measurement of the differences which exist has been greatly delayed. And yet some progress has been made.

Probably we have in America as good an opportunity to study racial differences as exists anywhere because we have here the American Indian and the Negro living in environments somewhat similar to that of the so-called white races. In this chapter we shall devote a good deal of attention to the Negro and to the Indian, since these have been most reliably measured in a number of traits.

The Negro. The advent of the intelligence test, both individual and group, has resulted in attempts to test out some of the theories held regarding the Negro. The studies may be divided roughly into two groups, (a) tests of children and (b) tests of adults, particularly in the Army draft. Comparisons are then made between the whites and the Negroes in at least two ways (a) the percentage of overlapping and (b) the intelligence quotient. Because the comparisons are frequently made between whites and Negroes of the same community and of the same age and because the tests have been given to children more carefully and in smaller numbers at one testing, the measurements of traits in children are more reliable. In both cases, the capacities of Negroes have suffered in comparison with whites because of their poorer environment which consists of the lack of cultural background in the home and of inferior schools in the South. Together, these conditions constitute a serious handicap in making scores on the intelligence tests. But when sufficient allowances have been made for these serious handicaps, tests show a reliable difference between the whites and Negroes in mental alertness or intelligence. A statement eminently fair to the Negro and biased in his direction could not possibly, i. e., from the mass of available data, conclude that more than 25 per cent of them reached the median of the whites of the same community. The percentage ranges from 4 per cent of Negro high school pupils of the Middle West reaching or exceeding the median white when measured on abstract tests of intelligence to 33 per cent of northern Negroes reaching or exceeding the median white when measured on Army Alpha.

Sample Studies. Since all of our intelligence tests do depend so largely upon environmental factors, we would be fortunate to secure results from a test very little dependent on such conditions. The rational learning test of Peterson seems to me to satisfy very nearly these requirements, since its successful solution depends so little upon environmental factors. This test is as follows:

> The letters A, B, C, D, and E are numbered 1, 2, 3, 4, and 5, but not in this order; that is, A is not 1 and E is not 5. The numbers are all mixed up any way, so that at first you will have to guess at them. When I call out A you are to guess whatever number you think I gave to A, and keep on guessing till I say "right." Then I will call out B and you must guess numbers for B till I say "right," and so on in the same way for C, and for D, and for E. Do you understand? Try to remember the number that belongs with each letter; for as soon as you are able to remember all of them twice through without a mistake, the test will be finished. Each letter has only one number, and no other one has that number; and when I say "right" you know what that number is. Do you

understand? Let's see how soon you can get through and remember all the numbers.[1]

The results of the application of this test in an impartial way to children of the city of Nashville, where Negroes as well as whites have good schools, may be seen in the following table:

TABLE XXX

PERCENTAGE OF ALL CHILDREN IN THE SEVERAL AGE GROUPS COMPLETING THE LEARNING WITHIN FORTY MINUTES

Age	*7 years*	*8 years*	*9 years*	*10 years*
White children:				
Number tested	18	108	84	82
Per cent completing problem	94.8	83.3	83.3	92.7
Negro children:				
Number tested	6	139	97	62
Per cent completing problem	16.7	43.2	64.9	76.5
Ratio of Negro to white: Percentage	0.18	0.52	0.78	0.83

Table XXX indicates a substantial difference between Negro and white children of the same age in the same community for the 8 year old whites almost double the 8 year old Negros, the 9 year old whites score 83.3 as compared with 64.9, while the 10 year olds get 92.7 as compared with the 76.5 for the Negroes.

The results from the individual and group tests simply corroborate the results given here except that this more abstract test makes the differences seem a little larger than the others do. For example, Trabue found that on the tests for literates,

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[1] Peterson, Joseph. *The Comparative Abilities of White and Negro Children*, p. 96.

31 per cent of the northern Negroes and 9.3 of the southern Negroes reached the median white; while on the tests for illiterates, the corresponding numbers were 17 and 3.5. The author found in children age 10 to 14 that 20–26 per cent of negro children reached or exceeded the median white. Therefore the evidence seems overwhelming that whites score higher on traits of general intelligence than Negroes do. In all cases, however, there are great overlappings between the two races. In no case has a trait been found unique in either race. The differences are matters of amount and not of kind. The abstract variety of intelligence brings out the differences most clearly. Furthermore if the children are graded for the estimated amount of white blood the general proportion holds that the greater the amount of white blood the greater the intelligence. The coefficient of correlation between the amount of intelligence and the degree of white blood is about .50. When the I.Q.'s are computed for Negroes they run from about 75 to 89. All studies bear out the general findings set forth here. In every study, for there is not one exception whether the subjects be adults taking the Army Alpha or five year olds taking the Binet, whether they live in New York or South Carolina, everywhere and always the results are the same. It is therefore fair to conclude that at least 75 per cent of the whites exceed the median Negro on intelligence tests.

In every test there have been found a few Negroes fully as capable as the most capable whites and a goodly number that are above the median of the whites. The figures only show that there are substantial average differences between the two races, but this fact of the capacity of a few should never be forgotten in any fair consideration of the educational, social, or economic condition of the Negro.

There are other traits, such as musical ability, mechanical ability, sociability—all of tremendous value—which remain to be investigated. The findings from such studies will undoubtedly give us further desirable information on differences between these two races.

The Indian. Another racial stock which is distinct enough in characteristics to be easily recognizable is the American Indian. Here again decided differences have been found whenever standardized tests have been used and here again there is no way of completely evaluating the effect of the environment.

A Sample Study. The study summarized here (Hunter and Sommermeier) consisted in testing 715 American Indians, located at the Haskill Institute at Lawrence, Kansas, with the Otis Intelligence Test. The Indians were then classified according to full-blood, three-quarters, one-half, and one-fourth, and the median scores computed for each class or group. Furthermore the median of the Indian performance could be easily compared with the 15 year old Otis Median for white children or with the median performance for, say, 14 year old whites, or with that of any other age.

In the first place the median performance for all the Indians was 82.64 points which may be compared with 122.58 points for white children at age 15. Since all the Indians were 14 and above, this seems a fair comparison. Furthermore, Table XXXI shows the median performance for each degree of Indian blood.

TABLE XXXI

Scores on the Otis Test for Full-Blood and Mixed-Blood Indians

(From Hunter and Sommermeier, 1922)

Amount of blood	$^1/_4$ *blood*	$^1/_2$ *blood*	$^3/_4$ *blood*	$^4/_4$ *blood*
Number tested	112	192	142	265
25 percentile	77.25	68.0	56.31	35.8
50 percentile (Median)	109.3	91.47	77.75	67.46
75 percentile	127.9	117.1	108.3	94.35
Percentage above Otis's Norms	25.7	18.4	9.1	6.8
Percentage below 8 year Norms for white children	5.5	6.9	11.2	25.9

Table XXXI shows clearly that the greater the amount of Indian blood the smaller the score. There are no exceptions to the rule. Furthermore quarter-bloods almost double the full-bloods at the twenty-five and fifty percentiles. The authors thought that the full-bloods were a better selection than that of the mixed bloods. By studying the last two rows, i. e., the percentage above Otis's norms, and the percentage below 8 year norms for white children, it is clear that the Indian under present conditions is not so able to pass the white man's tests as the children of the white man.

Rowe's study of 268 Indian children by the 1911 edition of the Binet Test obtained results substantially like those just presented. If we put the two sets of figures side by side, we get fair agreement.

	Below Age	*At Age*	*Above Age*
Hunter and Sommermeier	85	.7	14.03
Rowe	94.2	4.6	1.2

Furthermore, Garth's study of mixed and full blood Indians by means of association tests such as opposites, genus species, free association, logical memory and word building showed that mixed bloods exceed full-bloods, by 11 per cent in performing tests of the higher mental processes.

Indians are also found (Garth) to fatigue a little less rapidly than whites or Negroes.

In addition to Negroes and Indians, tests of various sorts have been given to children of many nationalities both in the United States and abroad. Chinese, Japanese, and Jewish children have been tested in the United States while the Filipinos, Hawaiians, Brahmans, and Panchamas have been tested in their own countries. However, the attempts have been so few and scattered that little knowledge of racial differences has resulted.

During the World War intelligence tests were given to about a million and three-quarters drafted men among whom were representatives from the various countries of Europe who had resided here for longer or shorter intervals. These men were tested with the Army Alpha group test for literates, with the Army Beta for illiterates and with the Binet-Simon individual test. The scores from these various tests were used by Brigham in computing the mental age level of the immigrants for the countries represented in the following table:

TABLE XXXII

Shows Mental Ages of Immigrants from the Countries Mentioned.[1]

	Stanford-Binet M. A.		*Stanford-Binet M. A.*
England	14.2	Belgium	12.56
Scotland	13.77	Ireland	12.2
Holland	13.76	Austria	12.16
Germany	13.41	Turkey	11.96
United States (white)	13.32	Greece	11.88
Denmark	13.26	Russia	11.45
Canada	13.25	Italy	11.2
Sweden	12.96	Poland	10.96
Norway	12.71	United States (colored)	10.71

This table merely indicates the differences between the type of immigrant the United States is receiving from the countries of Europe. The scores would depend more upon the selection of cases than upon the differences between the racial stocks in the countries represented.

In addition to the objective measures there have been many hypotheses and much conjecture concerning racial peculiarities, but until there is further careful experimentation and measurement nothing precise can be known concerning racial differences.

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[1] Brigham, Carl. *American Intelligence*, p. 124, 1923. Princeton University Press.

Objective measures show that there are substantial and reliable differences in intellectual traits between the whites on the one side and the Negroes and Indians on the other. In the case of the Negro the body of evidence is so immense, the agreement between studies so precise that there is scarcely any doubt left that there are substantial differences between the whites and Negroes. But in every case the overlapping is enormous and some Negroes are as bright as the brightest white. Negroes as compared with whites score equally as high as Indians. In general, however, the study of differences among individuals due to race is still in its infancy.

Maturity. Differences may arise among children for no other reason than that some of them have become older. Inner growth in and of itself unsupported by environmental influences would undoubtedly produce some of this change, but no measure that can be obtained is uninfluenced by environmental factors. The measures which we obtain as measures of mental growth represent a composite effect of heredity acted upon by environment. Furthermore, each trait and every combination of traits grow at their own peculiar rate. The curve for visual memory rises rapidly until the year 18 is reached while that of auditory memory makes a sharp break at 13. In weight discrimination the curve rises rapidly until the year 13 and then flattens out. The curves for a simple construction puzzle rise rapidly until 6 or 7 years, then flattens out. Finally, the curves for most intelligence tests follow a steady upward tending straight line until the years 14 or 15.[1]

While it is impossible to get an accurate measure of the contribution of maturity to individual differences some indication of its influence may be had by comparing the differences among individuals of the same age with the differences between the averages at the different ages. Figure 39 records the scores of the 10 year old children received on the National Intelligence Tests.

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[1] The shape of the curve depends somewhat upon the tests used. See Freeman, *Mental Tests*, Chapter XIII.

It will be immediately apparent that the differences are enormous, ranging as they do from 11.4 to 156.2. By means of these comparative scores it can be seen that as far as this test measures mental ability, these 10 year old children range far below the average for the third grade ability and considerably above eighth grade ability. More-

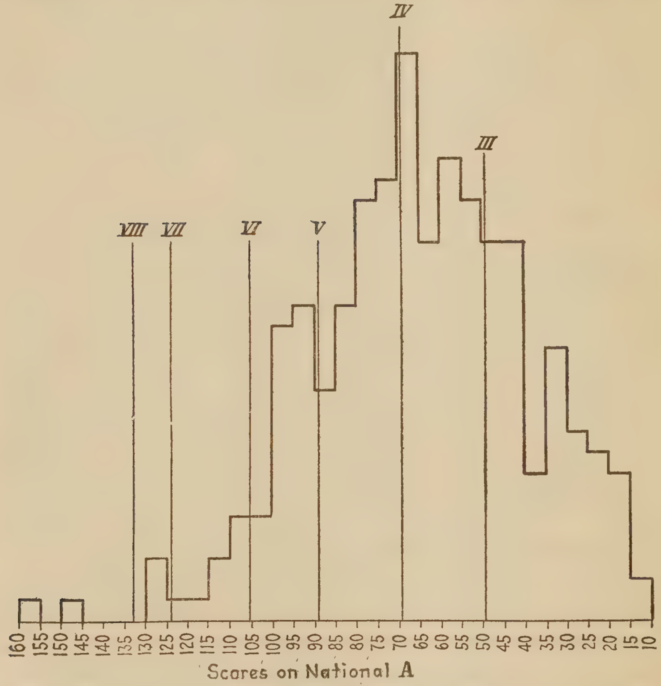

Fig. 39.—Variations of 285 10 year olds on National A. Note the enormous range of scores. The grade medians, indicated by Roman numerals, are plotted in as a basis of comparison.

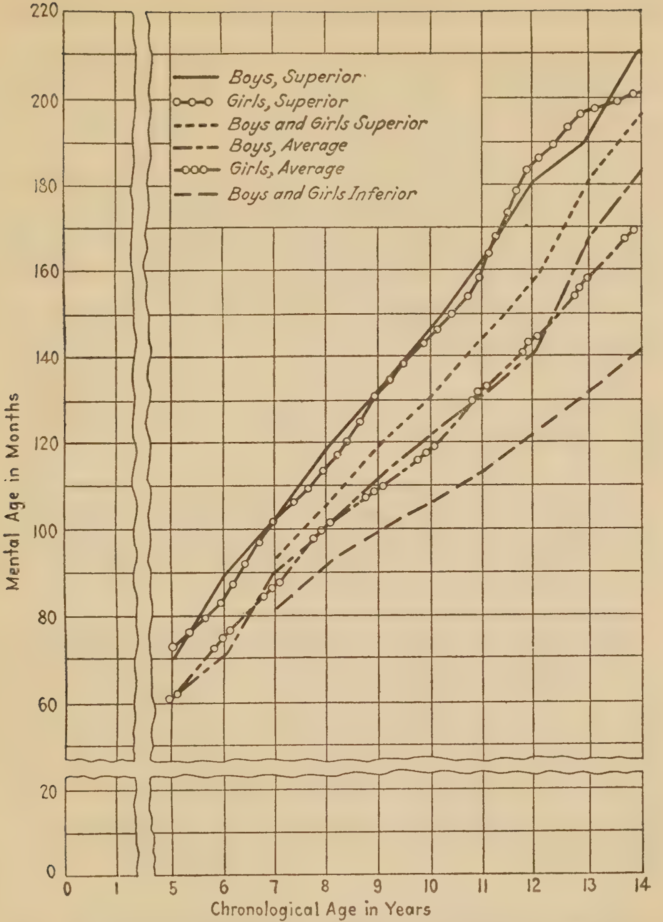

FIG. 40.—Mental growth curves for superior, average, and inferior children. The four curves of the mental growth of boys and girls taken separately are from Baldwin and Stecher, *Mental Growth Curves of Normal and Superior Children*, p. 11. They are based on the consecutive yearly measurements of children with the Stanford-Binet tests. The two curves in which the scores of boys and girls are combined are based on our own data. These are computed from the semi-annual measurement of 630 boys and girls for the upper curve and 590 for the lower curve. The test was National A and the time, three years.

over, they range below the standard for year 8.5 and noticeably above the average for year 15.5. If we take the difference between the third grade average and the eighth grade average we find 84 points, while the difference between the year 8.5 and 15.5 is 90 points. If this 84 and that 90 are compared with the difference between the highest and the lowest 10 year old, 144 points, we get a notion of the share which maturity has in producing individual differences. Let us put it this way: As far as these data go, a year's growth is measured by 15 points at the year 10. We find that the difference between 10 year olds, 144 points, is about nine years' growth or nine times as much as one year's growth. Maturity does play a part but the part is small.

The preceding graph (Figure 40) shows the shape of mental growth curves when the curves are computed from scores gained (1) on an individual intelligence test and (2) on a group test of intelligence. The scores are plotted on the same graph.

The mental age scores computed by Baldwin and Stecher from scores on the Stanford-Binet show a steady upward trend with very few variations. The superior boys and girls continue their superiority from year to year. Very little differences exist between boys and girls on this test. Similar results are obtained from the consecutive measurement of children upon a group test of intelligence. The general shape of the two sets of data bear a remarkable resemblance.

Individual differences are somewhat dependent upon maturity although this factor plays a comparatively small part. But it cannot be neglected for most traits proceed in their maturity at a steady pace up to a certain age and then grow less rapidly. The age of stopping depends on the type of trait maturing. Mental growth curves as indicators of the process of maturing show that mental development in the more general traits called intelligence proceed very steadily to age 14 or 15.

Summary

Differences between individuals loom large whenever precise measurements are made. A 10 year old boy may thus vary in intelligence from almost zero to that of an average 18 year old. Sex, race, maturity, family, and environment, each in turn contributes its share to the magnitude of these differences. Just what each contributes has not been determined.

In this chapter the shares of sex, race, and maturity in the production of differences have been discussed. In comparison with near ancestry or family these three contribute rather small parts of the total, and yet the differences are not negligible. Girls and boys differ noticeably in their capacities to memorize, quality of handwriting, reaction time, linguistic ability and in their interests in popular books. Negroes and whites differ in intelligence as measured by the standard tests. Whites and Indians show similar average differences. There are, also, considerable differences among children due to the simple fact of inner maturation of neurone and muscle.

QUESTIONS AND EXERCISES

1. Compare the differences among individuals in first grade and in high school. Under which condition are they greatest?
2. Draw three normal curves in which the percentage of overlapping is (a) 65 and 35 (b) 90 and 10 (c) 55 and 45.
3. In what motor abilities do boys surpass girls, and men surpass women?
4. In what traits do girls surpass boys?
5. In what school subjects do girls surpass boys?
6. Summarize the differences between boys and girls in their preferences for reading.

7. What might be meant by the "greater docility of girls"?
8. Are boys or girls more variable? Why?
9. What experimental evidence is there that girls are more suggestible than boys?
10. Why is Peterson's Rational Learning Test considered a good test for studying racial differences?
11. What percentage of negroes reach or exceed the median white, i. e., according to the studies?
12. In what trait or traits are the differences greatest? Would you infer from this that a different, perhaps a more practical sort of education, would be better for the Negroes? Why?
13. What is the relation in both Negroes and Indians between the percentage of white blood and scores on intelligence tests.
14. Do you consider the mental growth curves of children in intelligence a good indication of the effect of maturity? Why? Summarize some of the pitfalls inherent in the process of inferring mental maturity from consecutive measurements with the same mental test.
15. Ask the pupils of grades VI, VII, and VIII to write down the names of the five books they like best. Get also the records of their names and ages. Then tabulate for boys and girls separately the five most popular books. How do they differ from the results reported in this chapter?
16. With a knowledge of the differences in interests in books at hand to what use in the classroom might you put this information?

REFERENCES

Sex Differences

Frasier, G. W. "Sex Differences in Mental Traits and in School Achievement." Master's Essay, Stanford University, 1919.

Hollingworth, L. S. "Differential Action upon the Sexes of Forces which Tend to Segregate the Feebleminded," *Journal of Abnormal Psychology*, 1922, Vol. *17*, pp. 35–57.

Pressey, L. W. "Sex Differences Shown by 2,544 School Children on a Group Scale of Intelligence, with Special Reference to Variability," *Journal Applied Psychology*, 1918, Vol. *2*, pp. 323–340.

Pressey, L. W., and Pressey, S. L. "Further Data with Regard to Sex Differences," *Journal Applied Psychology*, 1921, Vol. *5*, pp. 78–84.

Starch, Daniel. *Educational Psychology*, Chap. V, 1927.

Thorndike, E. L. *Educational Psychology*, Vol. III, Chap. IX, 1913.

Negroes

Derrick, S. M. "A Comparative Study of the Intelligence of Seventy-five White and Fifty-five Colored College Students by the Stanford Revision of the Binet-Simon Scale," *Journal Applied Psychology*, 1920, Vol. *4*, pp. 316–329.

Ferguson, G. O. "The Mental Status of the American Negro," *Scientific Monthly*, 1921, Vol. *16*, pp. 533–543.

Jordan, A. M. "Notes on Racial Differences," *School and Society*, 1922, Vol. *16*, pp. 503–504.

Peterson, Joseph. "The Comparative Abilities of White and Negro Children," *Comparative Psychological Monographs*, July, 1923.

Pintner, Rudolph. *Intelligence Testing*, Chap. XVII, 1923.

Pressey, S. L., and Teter, G. F. "A Comparison of Colored and White Children by Means of a Group Scale of Intelligence," *Journal Applied Psychology*, 1919, Vol. *3*, pp. 277–282.

Schwegler, R. A., and Winn, E. "A Comparative Study of the Intelligence of White and Colored Children," *Journal Educational Research*, 1920, Vol. *2*, pp. 838–848.

Starch, Daniel. *Educational Psychology*, Chaps. IV and V, 1920.

Sunne, Dagny. *A Comparison of White and Colored Children Journal Applied Psychology*, 1917, Vol. *1*, pp. 71–83.

Thorndike, E. L. "Intelligence Scores of Colored Pupils in High School," *School and Society*, 1923, Vol. *18*, pp. 569–570.

Thorndike, E. L. *Educational Psychology, Briefer Course*, Chap. XXII, 1914.

Thorndike, E. L. *Educational Psychology*, Vol. III, Chap. X, 1913.

Trabue, M. R. "The Intelligence of Negro Recruits," *Natural History*, 1919, Vol. *19*, pp. 680–685.

Indians

Garth, T. R. "The Results of Some Tests on Full and Mixed Blood Indians," *Journal Applied Psychology*, 1921, Vol. *5*, pp. 359–372.

Garth, T. R. "A Comparison of Mental Abilities of Full and Mixed Blood Indians on a Basis of Education," *Psychological Review*, 1922, Vol. *29*, pp. 221–236.

Hunter, Walter S., and Sommermeier, Eloise. "The Relation of Degree of Indian Blood to Scores on the Otis Intelligence Test," *Journal Comparative Psychology*, 1922, Vol. *2*, pp. 257–277.

General

Baldwin, B. T., and Stecher, Lorle I. "Mental Growth Curves of Normal and Superior Children," *Universities of Iowa Studies*, Volume II, No. 1, 1922.

Brigham, C. C. *A Study of American Intelligence*, 1923.

CHAPTER XI

THE FAMILY AND ENVIRONMENT

Indications of the large part that family or near ancestry plays in producing individual differences have already appeared in our discussion of maturity. There it was shown that the differences in intelligence among 10 year old children were far greater than the average differences in either a year's growth or in a grade's growth. It was thus evident that maturity and environment played only a small part in comparison with heredity in producing individual differences. In the present chapter a discussion of the dominating influences of family or near ancestry and of environment is introduced.

I. FAMILY

In Chapter II sufficient attention has been given to the manner and conditions of inheritance. There it was seen that reflexes, instincts, emotions, and general learning capacity are transmitted through the germ cells by means of the quality and arrangement of the genes within the chromosomes. The genes are the simplest elements of inheritance and upon their number and arrangement the phenomena of inheritance depend. It is then this transmission of structure (through the germ cells) which makes possible the development of physical and mental traits. More particularly is it that immediate transmission from parents to children which is before us. This procedure would, of course, eliminate all differences due to the social influence of the family upon the children such as libraries, travel, conversation, and, in brief, culture.

There are four lines of attack upon the problem each of which corroborates the findings of the other. These are through the study of:

(1) transmission of feeble-mindedness and insanity from parent to child,
(2) transmission of genius from parent to child,
(3) the study of the degree of similarity between sibs, twins, and cousins,
(4) the intelligence quotient.[1]

1. *Feeble-mindedness and Insanity.* In tracing back the ancestry of occupants of institutions for the feeble-minded, investigators have found certain families in which there has been weakness of intellect for four or five generations. At the present, a large number of such studies agreeing in their essential findings have been made so that now the inheritance of feeble-mindedness has been well established. The fictitious names of these families, e. g., the Zeros, the Wins, the Ishmaelites, the Jukes, the Nams, the Sam Sixties, the Kallikaks, have become symbols of mental incompetency. At least three competent authorities agree that about 65 per cent of feeble-mindedness is transmitted directly through the germ cells.

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[1] Many writers of textbooks have emphasized the thought that equal amounts of practice make individuals more unlike rather than more alike and have offered this as an indication of the superior strength of heredity in comparison with environment. They have shown that in some experiments the five initially highest in an experiment would in two hours of practice gain more than the five initially lowest. But a recent article by Kincaid has cast serious doubts on the validity of this proposition. This investigator examined carefully twenty-four different studies bearing on this problem. She showed among other things: (a) that there is a larger coefficient of relative variability at the beginning of the practice series than at the end in 16 out of 24 cases; (b) that a greater gross gain was shown by the 25 per cent initially lowest as compared with the 25 per cent initially highest in 13 out of 24 cases; and (c) that there was a negative correlation between initial ability and percentage of gain in 22 out of 24 cases. Kincaid, Margaret. "A Study of Individual Differences in Learning," *Psychological Review*, 1925, Vol. *32*, pp. 34–53.

There is room for only one sample of such studies. I have chosen the Kallikak family because the case is clearest and the work was carefully done.

At the beginning of the Revolutionary War Martin Kallikak, Sr., a person of good family, joined, when a young man, one of the military companies that were formed for purposes of protection. At one of the taverns frequented by the militia he formed a temporary union with a feeble-minded girl from which union was born Martin Kallikak, Jr. From this escapade in a tavern there have come 480 descendants "One hundred and forty-three of these, we have conclusive proof, were or are feeble-minded, while only forty-six have been found normal. Of these 486 descendants 36 were illegitimate; 33 sexually immoral; 24 confirmed alcoholics; 3 epileptics; 82 died in infancy; 3 were criminal; 8 kept houses of ill fame." On leaving the Revolutionary Army, Martin, Sr., married a normal girl of his own class from which marriage had sprung 496 descendants all of whom were normal. Only three were found who were in any way unusual. Two of these were alcoholic and one sexually loose. It is interesting to note in Figure 41, which carries the family tree through three generations of feeble-mindedness, the number of black sheep in one family. This study and dozens of others like it leave no doubt about the inheritance of feeble-mindedness.

When we turn to insanity we find that in about 60 per cent of the cases there is good evidence that the weakness is transmitted from parent to offspring. In a study by Rosanoff and Orr, of 1097 offspring of neuropathic ancestry 146 died in childhood, 351 were neuropathic, and 586 normal. Of 75 offspring in which both parents were of neuropathic stock, but one parent of neuropathic stock on one side only, 11 died in infancy and 54 were neuropathic, leaving only 10 normal. In far more cases than chance would allow, we find in some families types of insanity appearing

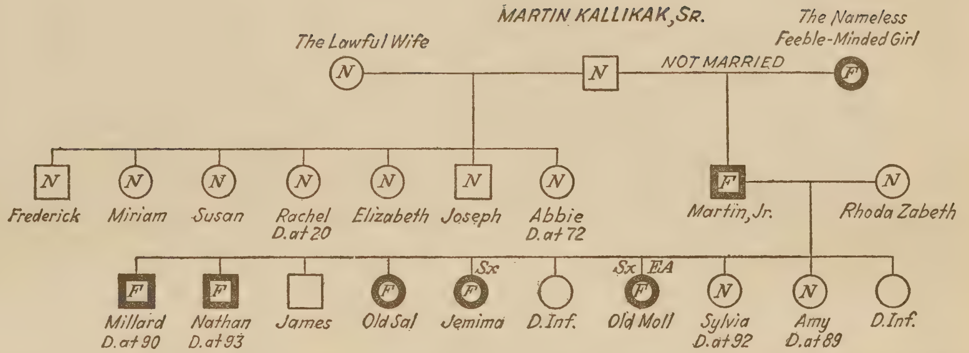


FIG. 41.—The effect of introducing a feeble-minded strain into a normal line. N = normal. F = feeble-minded. Sx = sexually immoral. A = alcoholic. D = deaf. D. Inf. = died in infancy. E = epileptic. (Goddard, H. H., *The Kallikak Family*, p. 37, 1912. The Macmillan Company. Reprinted by permission.)

from one generation to the next. It would appear that in both feeble-mindedness and insanity heredity plays a very important part. The evidence is clearest in feeble-mindedness, since the children do not react at all to their environment and show from the tenderest years evidences of their weakness. In the case of insanity in which an individual seemingly normal for a long time loses his mental balance there is always the interaction of environment (exciting cause) upon the inherited structure (predisposing cause) which brings about the catastrophe. It is impossible at times to separate these two factors.

2. *Genius.* Genius, too, seems to run in families in a great many cases. By "genius" we do not mean a species different in quality from the ordinary individual but one who has a greater capacity along one or more lines, such great capacity that he stands out preëminently above his fellows in these traits. The evidence here is not so convincing as in the case of feeble-mindedness but all of it agrees that certain families produce far more than their share of eminent men.

Sir Francis Galton in his book *Hereditary Genius* (1869, 1892) was one of the first men to approach this matter scientifically. He studied the family records of 977 men each at least as eminent as one in 4000. The types of profession represented, the number in each profession, and the number of relatives of equal eminence with their appropriate degrees of relationship are shown in Table XXXIII.

TABLE XXXIII

Shows the number of eminent relatives of 977 eminent men as selected by Sir Francis Galton in his book, *Hereditary Genius*. Eminent defined as "distinguished as 1 in 4000"

	Number	*Father*	*Brother*	*Son*	*Grandfather*	*Uncle*	*Nephew*	*Grandson*
Judges	262	22	30	31	13	15	16	16
Statesmen	130	13	15	19	11	7	7	4
Commanders	89	12	13	8	4	2	9	3
Literary men	119	16	14	17	8	8	8	3
Scientific men	148	11	20	26	6	7	10	6
Poets	57	4	8	9	1	1	10	1
Artists	97	9	14	25	2	4	5	5
Divines	75	7	9	10	5	10	1	4
Total	977	94	123	145	50	54	66	42

Total: Father, Brother, Son (first degree), 362.

Total: Grandfather, Uncle, Nephew, Grandson (second degree), 212.

The probable number of Fathers, Brothers, and Sons, together, 1.

The probable number of Grandfathers, Uncles, Nephews, and Grandsons all together, 3. (Galton, Sir Francis, *Hereditary Genius*, p. 308, 1869 and 1892. The Macmillan Company. Reprinted by permission.)

The table shows that these 977 men are, far more than chance would allow, related to each other. Furthermore, the nearer the degree of resemblance the larger the number of relatives, for example, the number of fathers, brothers, or sons is 362; while the number of grandfathers, uncles, nephews, and grandsons is 212. If we compare these numbers with the expectancy, 1 for the first group and 3 for the second group, we get some indication of the tremendous influence of heredity in the production of genius. Galton himself thought that genius is inherited and that it rises above ordinary environmental limitations. His wide study convinced him that even the best environment was insufficient to raise an individual to heights of eminence.

If this were an isolated study its findings would not be so impressive but at least three other studies have given substantially the same results. These are Frederick Adams

Woods' *Mental and Moral Heredity and Royalty* (1906), *Heredity and the Hall of Fame* (1913) by the same author, and finally Terman's *Genetic Studies of Genius*, Vol. I. These three studies will be briefly summarized.

Dr. Woods rated 671 members of royal families on a scale from 1 to 10. The rank of 1 was given to the feeble-minded and 10 to the most brilliant of them all, to such men as Gustavus Adolphus and Frederick the Great. The basis of his ratings was the accounts of each sovereign given in standard encyclopedias. Greatness ran in families as well as feeble-mindedness and insanity. Instead of the brilliant sovereigns appearing in a haphazard manner upon the map of Europe, they appeared in certain well-defined segregated areas. In the families of four great sovereigns the most of the brilliant ones occurred—that of Gustavus Adolphus, Frederick the Great, Isabella, and William the Silent. The inheritance of the throne took place as frequently among the stupid as among the talented, so that one environmental factor, that of succession to the throne, had no influence in producing talent or stupidity. For example, there were 71 per cent in rank 1; 69 per cent in rank 5; and 57 per cent in grade 10 who inherited the throne; the rest obtained it in some other way. This study is particularly interesting because we have most of the individuals growing up in excellent environments but differing among themselves in their attainments.

The same author made a study of the family relationship of those admitted to the Hall of Fame (1913). To project these illustrious individuals upon a proper background it was necessary to make studies of other illustrious men. In pursuit of this idea Dr. Woods studied the biographies of men which appeared in Jameson's *Dictionary of United States History* and Lippincott's *Biographical Dictionary of the World*. In these two sources were found 3,500 names, each about as distinguished as 1 in 10,000. He calculated that if the average person has 20 near relatives the chances would be 1 in 50 that the average person would have a relative in these lists. But we find that these 3,500 are related to each other as 1 to 5. If the most celebrated of them are taken the ratio rises 1 to 3, but the chances that the members of the Hall of Fame have relatives in these lists are 1 to 2. It is thus seen that these most distinguished individuals are from 500 to 1,000 times as much related to other distinguished people as is the ordinary mortal. Moreover, there appear in the record books of famous men several members of the same family. "In Jameson's *Dictionary of United States History* and Lippincott's *Biographical Dictionary of the World* are included 13 Lees, 11 Adamses, 10 Lowells, 9 Dwights, 8 Trumbulls, 7 Livingstons, 7 Bayards, 6 Irvings, 6 Sewalls, 6 Prescotts, 5 Channings, 5 Edwardses, 5 Mathers, 5 Randolphs, and over 100 other families in which from 2 to 4 noted Americans can be found closely related to each other" (p. 447).

In the third investigation, which was a study of gifted children, Terman has discovered some facts which substantiate the findings set forth in the just mentioned studies. In this investigation, 643 children were selected for study by means of teachers' nominations of the brightest and youngest in the room. These were tested first with a group test and then with the Stanford-Binet until there were left 643, all of whom had I.Q.'s of 140 and above. What do we find among these bright pupils concerning the influence of heredity? In the first place "seventy-three families have yielded two subjects, and nine three or more. The number of families with two subjects is more than 1200 times the number chance would give." Furthermore, nearly a fourth of the members of the Hall of Fame are known to be related to some of the group. Five of the parents, three fathers and two mothers, are listed in *Who's Who*. And finally, "Parents and Grandparents have held posts of responsibility in very great number, including 20 cases of major national office, 26 of major state office, 67 of major religious or fraternal office, 4 college presidencies, 23 professorships in colleges, 74 positions as superintendent or manager of a large factory or corporation, and 18 bank presidents."

3. *Cousins, Sibs, Twins.* Given identical environments, differences among individuals are due to heredity or given equal heredity, differences appearing are due to environment. Since the combination of genes within the chromosomes is different for each individual even in the same family it is a most difficult task to get two individuals with the same heredity although, in heredity, identical twins seem to be about as near identity as can be found. The second possibility, that of identical environment, seems more possible of attainment. Children of the same parents come very close to this identity of environment. Now sibs (i. e., brothers, sisters, brothers and sisters) differ from twins in being less alike in inheritance but are like twins in having the same or nearly the same environment. For example, brothers born two or three years apart would differ very little in their environment. Possibly the family fortunes had changed in these two years, but if a large number were considered the changes up or down would possibly be balanced. The differences in environment between twins on the one hand and between sibs on the other would be slight indeed. The question then resolves itself to this: If a series of pairs of twins and a series of pairs of sibs are measured on any trait how close will the resemblance be (a) between sibs, and (b) between twins?

Various sorts of traits have been measured beginning with such physical traits as stature, eye color, head length, head breadth and continuing through such mental traits as vivacity, temper, and popularity, to the cancellation of A's, misspelled words, addition, multiplication, opposites, and finally to arithmetic, reading, writing, intelligence, and the Stanford Achievement Test. In the size of the coefficients of correlation obtained, physical and mental measurements are very closely alike. The writer threw into one table 102 correlations between sibs in various traits (from Hildreth, 1925). They ranged from .18 or .19 to .75 with a median at .513. Twenty-eight correlations between twins were found. These ranged from .37 to .96 with a median at .765. It seems, then, that much of the difference between .51 and .76 would be due to heredity.

If we introduce in this discussion paternal correlations, i. e., the correlations between traits in parents and traits in children and those between cousins (Dexter, 1924) we get the following series:

	Chance	*Cousins*	*Paternal*	*Sibs*	*Twins*	*Same Test Repeated with Same Group*
Intelligence tests	0	.20	.30	.51	.76	.85 (about)

This shows an increased closeness of resemblance in mental traits in proportion to the increase of blood resemblance. One writer (Hildreth) found that in case of true sibs (orphans) reared apart the correlation was .495 when correction had been made for the curtailed range brought about by the smallness of the numbers considered.

In some cases a pair of twins reared together has been studied in great detail. In one study (Gesell) 25 physical measurements were made including the ordinary measures of height and weight, such measures as friction skin patterns, blood pressure, and diameters of carpal bones. The physical measures were surprisingly alike even in small details, e. g., they were the same in friction skin patterns. The 17 mental tests given them were almost as nearly alike as the physical measures, e. g., on the Stanford-Binet Vocabulary one of the twins failed on 16 of the test words;

the other failed on these 16 and on one more (*harpy*). The graph of these two individuals in these 17 mental tests ran parallel and at about the same level in every instant. But in this case, the two children dressed alike, were fed alike, and in general were stimulated by the same environment. What happens when the environment is quite different?

There is at least one case on record (Muller, 1925) in which twins, two years after birth, were adopted into two different families; the one living in Wyoming; the other in Arizona. One of the twins, B, was brought up by foster parents who did mining, hauling, and logging in Wyoming. As a child B was out with the teams all day and altogether received only four years of formal schooling, one of which was a nine months' course in a business college. The other twin, J, grew up with people who owned a ranch and road house in Arizona. She was sent right through elementary and high school and afterwards took some summer and university work. Both twins read voraciously, as children, and both were extremely active and energetic; as adults (the tests were made at 30 years of age), both were keenly interested in their respective communities, taking part in all worth-while activities. These two sisters grew up in quite different environments. After separation at 2 years of age, they did not see each other until they were 18 years old and since that time have remained apart nine-tenths of the time. The physical measurements showed remarkable resemblances: they had the same height to the one-half inch, same weight to a pound, same iris patterns, both were left-handed in childhood; and both had the same type of ankle prominences. In mental traits the resemblance was just as remarkable. On the Army Alpha, B scored 156, J scored 153; on the Otis Self-Administering Test, B scored 64; and J scored 62. These differences are no greater than would be the difference between two scores of the same individual taking the tests on two separate occasions. There were some striking differences between them in their scores on the Will Temperament Test, and in tests of emotional and social attitudes.

From our consideration of sibs and twins the evidence is accumulative that heredity plays an enormous part in causing resemblances between individuals. Cousins resemble each other more closely than individuals taken at random, fathers and sons are more alike than cousins, sibs on the average have many traits alike, while twins are most alike. This statement holds, whether the measurements are of physical or of mental traits.

4. *The Intelligence Quotient.* The Intelligence Quotient (I.Q.) indicates the rate of mental growth from year to year. As has been indicated (p. 31) it is the mental age divided by the chronological age. Children differ widely in their I.Q.'s, ranging from those of approximately zero to about 200. What causes these differences? Is it the difference in the environment or is it the difference in heredity? If environment is the cause then a change in environment would cause a change in the I.Q. If it is heredity then the I.Q. would change very little when the environment changes. If environment were the cause, children in the same family would have about the same I.Q. and all children of poor environments would have a low I.Q., while all those in excellent environments would have high I.Q.'s. All these assumptions are false, for children in the same family do have widely differing I.Q.'s; some children in the most miserable environments have high I.Q.'s; and many children brought up in excellent environments have low I.Q.'s. Since the elements of such tests as the Binet-Simon test are largely common to all environments the scores upon this test are very largely indicators of inherited capacity.

The intelligence quotients on an average do stay remarkably constant as is indicated by the following tables:

TABLE XXXIV

Average Intelligence Quotients (Stanford-Binet) for 36 Cases on Five Yearly Examinations

(Baldwin and Stecher, 1922)

Exam. 1	*Exam. 2*	*Exam. 3*	*Exam. 4*	*Exam. 5*
115.4	119.5	119.8	123.9	126.7

TABLE XXXV

Average Intelligence Quotients (National Intelligence Tests) for Four Consecutive Semiannual Examinations

(Jordan and Armstrong, 1926)

	Exam. 1	*Exam. 2*	*Exam. 3*	*Exam. 4*	*Number of Cases*
Group I	103.7	108.0	104.5	110.6	101
Group II	106.4	110.9	106.7	113.7	169
Group III	84.2	87.3	83.9	89.9	162
Group IV	86.9	89.2	83.6	89.6	152

In both tables there is a slight tendency for the I.Q. to increase from year to year. This may be attributed directly to familiarity with the tests. The significant fact is that an I.Q. of 87 tends to stay close to 87, of 110 close to 110 throughout the years tested. The interpretation of this would be that in spite of the enriched environment of the school, in spite of the wider contacts with the more common environment of the community the I.Q.'s fail to change appreciably from year to year. This constancy of the I.Q. certainly is strong evidence in favor of the influence of heredity.

Summary of the Influence of Family. From all the evidence which has been submitted one properly infers that family plays a large part, a very large part, in producing the differences among individuals. In the first place, feeblemindedness and insanity appear far more frequently than chance would warrant in long lines of individuals. Probably in no case is the evidence so clear as in the inheritance of a neuropathic constitution. In the second place, almost as clear in its implications, is the large number of men of the first rank appearing in family groups. Dr. Woods estimated that about 50 per cent of the men of genius sprang from a few distinguished families; the other 50 per cent came from the remainder of the population. In the third place, although sibs and twins enjoy environments quite similar, twins are significantly more closely related than sibs. And the relation of cousins, of parent and child, of sibs, and of twins form a series of correlations of increasing size, indicating an increasing closeness in resemblance. And fourthly, intelligence quotients vary among members of the same family, low I.Q.'s sometimes occur among the best families and the highest ones among the worst families. In addition, the I.Q. seems to remain approximately constant despite varying environments.

The evidence is consistent. It shows that heredity is far more important in determining differences among individuals than many of us are willing to believe. In the extreme cases environment appears almost powerless either to prevent genius from rising or in raising the feeble-minded to higher levels. In the civilized world to-day there are no "Mute Inglorious Miltons" for they rise from their poverty, brush the dust from their clothes and seek more pleasant pastures. Sometimes they change their environment but they never are either mute or inglorious. On the other hand, not only can the feeble-minded not rise but they cannot even be lifted to a higher mental level. Down from the past comes to us that wonderful story of Itard giving his personal time during four years of a distinguished career trying to educate the Wild Boy of Aveyron but finally giving up in despair. The feeble-minded can be trained in good habits but they can never be taught to plan.

The genius and the feeble-minded are less affected by their environments than those of medium ability. This point we shall treat further in the next section.

II. Environment

If we consider only the extremes—those of feeble minds and geniuses—it does not appear that environment could under any circumstances exert a very great influence. We thus find eminent men who believe that a genius will rise above any environment which would surround him in any civilized country to-day and that contrariwise the environment even of the best is unable to produce gifted individuals. They (e. g., Galton) further urge that if twins are born unlike, environment is utterly incapable of making them more alike; or if they are born alike, changed environment fails to produce much difference in them. Then, too, those who train the feeble-minded are unable to raise the level of intelligence of these mental incompetents. In the realm of certain disabilities in school subjects (e. g., in spelling) a long period of careful training in the best modern methods of teaching spelling produced individuals able to spell the words specifically taught them, but had no effect upon the general ability to spell. And finally, some of those who have worked a great deal with mental tests find that intelligence is inborn, that environment changes this innate capacity very little, probably not at all, and that it gradually develops through some inner urges of its own to maturity.

In the face of such an array of facts those who believe in the power of environment to change men's lives are not dismayed, for they recognize that not all of the story has been told. Some of them at least are willing to admit that environment is unable to completely substitute anything for the lack of inheritance. They know that without a cortex a child does not develop, indeed cannot, whatever be the environment. On the other hand, barring such extremes as profound idiocy, they hold that environment does play an important part.

Temperature itself plays an important part in human development. From the very beginning of life the oösperm (fertilized ovum) requires a certain even temperature, much deviation from which produces either death or an abortion. While the knowledge concerning the effect of environment upon human embryos is inferential, that concerning its effect upon embryos of lower animals is well known. T. H. Morgan has shown, for example, that some fruit flies tend to inherit supernumerary legs, but if those inheriting this trait are kept properly warmed the extra number of legs do not appear. Moisture and nutrition exert a profound influence upon growing embryos. Indeed it may be said that no inherited trait could possibly appear without the coöperation of the environment broadly conceived.

In the mental realm just as surely as in the physical and physiological is it certain that environment plays a considerable part in human development. Imagine a young infant of the best inheritance placed upon a desert island. Let us further suppose that while this infant is asleep food and water were brought to him so that he never by any chance happened upon either another individual or upon any fragment of our civilization. This infant might grow into maturity, might become a fine physical specimen, but what of his mental development? It would be as low as that of an imbecile. He would have no language further than possible emotional outbursts, birdcalls and such like. No ideas of morality, of religion, of cleanliness, of manners, of human relations could possibly be his. He would tear his food with his naked hands. His emotions would be as uncontrolled as the wind except in so far as he had learned to control them by painful contacts with his physical environment. Science would be to him a closed book except that his observant nature may have been influenced by diurnal variations in climate and the sun, moon, and stars. If one carries on these imaginings in all their details he can gain a capital notion of the influence of environment.

Because of the overlapping of generations, mankind is unusually well adapted to transmit its knowledge, its wisdom to the oncoming generations. The extended period of infancy of the human young with its many years of dependency, its long period of admiration of the doings of its elders, offers an unrivaled opportunity for human parents to bring to bear upon their offspring the full weight of the environment.

Specific Influence of the Environment; Formal Schooling. No one to-day doubts the influence of the school upon individuals of all grades of inheritance. Itard, after having worked for four years with the Wild Boy of Aveyron (page 324), eventually threw up his hands in despair when the young man burst forth one day into an emotional storm. But Seguin, having watched carefully the process, observed that the boy had made great improvement and with probably a temperament more suited than Itard's for the work, began, after the difficulties had been removed, the instruction of feeble-minded children. His influence spread, for his work had genuine merit in pointing out the incontestable fact that even the feeble-minded profit highly by the proper sort of instruction. It was the author's good fortune to trudge, with two others, out through the snow, from the car line in Waverley, Mass., to the Institution for the Feeble-minded. The three of us spent with that Apostle to the Feeble-minded (Dr. Fernald) two hours as instructive and delightful as one might imagine. He had brought in for our inspection the record of one case after another, citing, sometimes with a glow of pride, the advancement that this or that one had made. Sometimes this one had returned to his ordinary work and was making good, at other times, that one was making nearly fifty dollars a week. He could demonstrate with figures that the Institution at Waverley was paying good dividends to the state of Massachusetts in the increased earning capacity of the boys and girls trained there. These individuals were feeble-minded but the environment adapted to them had helped them form good habits, had taught them something of morality, of the rights of others, and of their own rights, had helped them fit themselves for jobs which could be accomplished with their low levels of intelligence.

Those individuals above the level of feeble-mindedness seem to profit even more than the feeble-minded by their contact with suitable environment. In the earlier days of the investigation of the influence of instruction upon improvement in school subjects, men like Rice and Cornman had cast considerable doubt upon the capacity of the school to improve the ability of children to spell. They canvassed many situations which might have contributed to success in spelling: such as time given to the studies, methods employed, home reading, cultured parents, and place of birth of parents; but could find no determining cause of good or poor spelling. But more recent investigations have shown that the right methods used in teaching spelling do produce demonstrable differences between classes and that it is not the amount of time but the way that the time is used that counts.

A good illustration of the influence of careful drill in spelling is given by one investigator (Wallin). In the city of Cleveland intensive repetitions of words difficult to spell produced a measurable difference in a year's time. Out of 120 words to be spelled the pupils averaged 1.5 words incorrectly spelled in 1906, while in 1907 the number incorrectly spelled was less than .5 of a word. Under such a careful procedure the eighth grades of that city improved in spelling efficiency from 74 per cent correct to 94 per cent correct within a period of three years.

Even with the gifted themselves education counts tremendously. Some, like Lincoln, are able to overcome their handicaps of formal education by industrious application in odd hours but even they might have soared to greater heights had they been aided by a carefully selected environment. As has been indicated, provisions for the proper advancement and education of gifted children claim the attention of many thoughtful educators at the present time.

Environment thus exerts a potent influence in developing original nature. Several students have attempted to discover more exactly the nature of this influence. One investigator (Odin, 1895), for example, made a very serious attempt to discover the conditions under which French men of letters grew up. He canvassed the leisure time which they, as young men, enjoyed; their intellectual contacts; their family traditions; their education; their facilities for research; the public attitude in regard to science and letters; the types of religious beliefs held by their parents, the amount of travel they undertook, etc. Many of these exerted no dominating influence. Some did. Centers of population, particularly if there were unusual opportunities for cultural contacts, did make a difference. Education, wealth, and particularly leisure, if well directed, all seemed to be correlated closely with the number of distinguished men of letters.

TABLE XXXVI

Showing Relation between Place of Birth and Number of Distinguished Men of Letters

(Odin, 1895)

	Men		*Women*	
Place of Birth	*No.*	*Per cent*	*No.*	*Per Cent*
Paris	1229	23.5	112	42.1
The Large Cities	2646	50.6	111	41.7
Rural Districts	1265	24.2	29	10.9
Châteaux	93	1.8	14	5.3

This table certainly indicates that a very large per cent of men of letters were born in urban areas; but whether the stimulating environment of a great city caused these men and women to write brilliantly remains undetermined.

One writer who concurred with the position just advanced by Odin was Lester F. Ward. He was so much interested in the point of view advanced by Odin that nearly a hundred pages of one of his books are given over to the review and criticism of Odin's work. In discussing the importance of education for brilliant men of letters he says: "In one sense, the local, economic, and social environment, are all educational environments, and their influence on the production of men of letters, of science, of art, and of distinction generally depends entirely on the extent to which they are educational. They all combine and converge to this end, and practically constitute the educational environment." From Odin's work, Ward shows that 98 per cent of the talented authors of France received a good education in their youth. In conclusion Ward states: "It is impossible for a man of genius to attain eminence and remain all his life in the country." (Ward, 1906, p. 215.)

Under what conditions do distinguished men of science appear? In order to discover some answer to this question, one investigator (Cattell) searched out the place of birth of a thousand leading American men of science. Since the majority of the men he studied were born before 1860 he used the population at that time to compute the number per million who were born in each state. One of the most startling findings was the very large number of scientists born in industrial New England and the extremely small number born in the rural South. In Table XXXVII are given the number of scientists per million population who were born along the Atlantic seaboard.

TABLE XXXVII

Number of American Men of Science per Million Population Who were Born in the States Named

(Cattell, 1906, p. 733)

	I–V	*VI–X*	*Per Million in 1860*
Massachusetts	60	74	108.8
Connecticut	26	14	86.9
New York	99	84	47.2
Pennsylvania	32	34	22.7
Maryland	12	14	37.8
Virginia	5	8	8.8
North Carolina	1	4	5.0
Georgia	1	2	2.8

(Numbers I–V are the more distinguished 500; and numbers VI–X the less distinguished 500.)

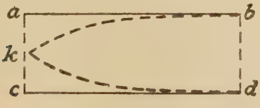
This segment is a fair sample of the total table and it does indicate that scientific men are born near stimulating centers of population. Cattell's own observations are pertinent: "It is unlikely that there are such differences in family stocks as would lead one part of the country to produce a hundred times as many scientific men as other parts. The Negroes may have a social disqualification, but even this is not proved. The main factors in producing scientific and other forms of intellectual performance seem to be density of population, wealth, opportunity, institutions, and social traditions and ideals. All these may ultimately be due to race, but, given the existing race, the scientific productivity of the nation can be increased in quantity, though not in quality, almost to the extent that we wish to increase it." (Cattell, 1906, pp. 734–735.)

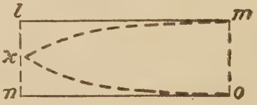
In both of these studies (Odin and Cattell) the inference that certain environmental factors produce these men of distinction is a highly problematical one. Another interpretation of the same facts might be that men and women of great talent, the fathers and mothers of the men studied, had felt the stimulating influence of great centers of population and had moved there. Their children thus inheriting the greater capacity of the parents, developed into more brilliant writers and scientists than those around them. One must not forget also that the selective power of the environment must have played a tremendous rôle then as now. In the rural South, e. g., the law and politics, not science, called to their banners the most brilliant minds.

This selective power of the environment is well illustrated by an investigation (Thorndike, 1913) of the occupations into which Phi Beta Kappa men entered at various times in our national life. Four professions—law, medicine, teaching, and the ministry—were canvassed during the years 1840 to 1894. During that time the percentage entering law and medicine remained very nearly the same but rather sharp changes appeared in teaching and in the ministry. During this period (1840–1894) the percentage of scholarly men going into teaching as a profession increased from 9.4 to 25.4 per cent; while those going into the ministry decreased from 37.5 per cent to 14. The environment as this study shows offers far more enticements to men to enter a profession at one time than at another. Thus nearly three times as many young men went into teaching in 1894 than in 1840 simply because the environment had made this a more attractive occupation for them. The environment, therefore, exerts a potent influence in causing an individual to decide the type of occupation which he will enter.

Environment thus develops inherited nature. Properly simplified it affects even those feeble in mind; properly complicated, it stimulates the bright to greater effort. To the great range of individuals between these extremes it is a tremendously potent force. It helps the individual form habits in accordance with the customs of the times. It stimulates and draws out reactions favorable to it; it inhibits and negates reactions unfavorable to it. Manners, customs, morals, certain phases of temperament, politics, language, occupation, in general those things ordinarily designated as civilization, are directly dependent upon its influence.

Relative Influence of Heredity and Environment. If we balance on the one side heredity as represented by remote ancestry and near ancestry, sex, and certain phases of maturity and upon the other, environment and other phases of maturity and designate all the former as "heredity" and all the latter as "environment," then the relative influence of these two latter has not been determined. There is no question but that the influence of the environment upon an individual varies with the heredity stimulated. Persons who live in university towns are frequently struck by the numbers of individuals who come from a distance to be stimulated by the environment of a university; while others, who live almost within the shadows of its towers, find in its presence only a stimulation to sell butter and eggs to its faculty, who never attend even its popular lectures and who remain to the end of their days totally unaffected by its intellectual influence. Individuals vary greatly in the way they react to any environmental stimulus and they frequently either change their environment or seek other types. One might guess that heredity counts for something like 60 or 70 per cent in development and environment about 30 or 40. But the two forces are so intertwined as to make it impossible to separate their influence.





Suppose the distance from a–b to c–d represents the extreme limitations of an individual's inherited nature. Let a–b represent his highest reaches and c–d his lowest depths. Now the individual, k entering the environment which stimulated him strongly to do his best might rise along the dotted line to a–b or, vice versa; he might tend along the solid line to c–d. Now let l–m and n–o represent the limits in development of another individual whom we shall suppose is x. In a good environment he might rise to l–m. It can easily be seen that if k found a poor environment and x a good one, x, although of inferior capacity to k, might surpass k in general development.

Provision for Individual Differences. Such large differences as have been demonstrated exert a profound influence upon the school progress of the child. Children advance in each subject at such widely differing rates that those who start together in the fall are far apart by spring. Sometimes, even, they do not begin together in the first place. This results in such widely separated individuals of a group as have been shown among children of the same age and of the same grade.

In the old one-room school, instruction was largely individual, but since the days of Lancaster and Bell and the impelling movements for educating all the children, group instruction has been the rule. Children of about the same age have been started together in the first grade, and they have proceeded together from grade to grade with the exception of those who for one reason or another have failed to pass the work of the grade. A few, to be sure, earned extra promotions. But in the vast majority of cases there has been a sort of steady onward progress of pupils through the grades. Promotion came once a year and at a regular time. Some have characterized this steady marching through the grades as a "goose step" parade.

The study of individual differences has demonstrated that this massing of children of about the same age into one grade and keeping them together is wrong, all wrong. It has shown that progress among pupils is so different, and the resulting differences are so great that the instruction which the dull pupil understands bores the bright one and that which the brightest understands confuses the dull one. Provision for different rates of progress therefore, almost of necessity, has to be made. In general, there are two ways in which this has been accomplished. In the first place the grades have been kept intact, but various changes are made in the methods of grouping; in the second place, radical changes are made in the organization of the groupings and vast latitude is given the individual pupil in determining his rate of progress.

I. The grades are kept intact but changes are made in the methods of grouping.

a. *Ability Groupings.* By means of intelligence tests, teachers' estimates, school marks, and such like, children are divided into three groups, sometimes called the x-y-z groupings. About 20 per cent of the brightest pupils are placed in the x group, and about 20 per cent of the dullest in the z group. The others are placed in the y group. In some cases the brightest pupils go at a faster rate than the other groups; in other instances, the curriculum has been enriched for the brighter pupils and only the minimum essentials have been taught to the dull. In other cases the curriculum has been left unchanged but the sections advance at a different rate.

b. *Coaching the Backward.* Those behind in school work have ever been the burden of their teachers. Some schools have provided an hour a day extra time to be devoted largely to the retarded children with an additional teacher or two who attempt to help out the backward pupils. Extra classes on Saturday morning or in the afternoons are at times provided for the slow. Sometimes additional assignments with or without credit, depending upon the school, have been made to the bright pupils. Finally intensive study may be made of the child who is definitely retarded. His eyes, ears, nose, and throat are carefully examined, various types of tests are given to locate the difficulty which, once it is found, is attacked vigorously and the trouble removed if possible.

II. Substantial changes are made in the ordinary ways of grouping pupils.

In the attempts to individualize instruction and yet preserve the group spirit perhaps the most conspicuous success has been at Winnetka, Illinois. In the schools of this city, the activities of the pupils are centered around the common essentials of knowledge, the knowledge and skills which are needed by all the children in common on the one hand; and the socialized and self-expressive activities on the other. From two-thirds to one-half of the day is given to mastering the common essentials. These consist of what might be called the tools of education. The subject matter is carefully worked out into definite units of instruction each of which has its appropriate test so that the child can know when he has mastered a designated section. When he has demonstrated that he has mastered a certain section the teacher enters that fact on his record and he proceeds to the next unit. Each child may spend a shorter or longer time on each unit. Thus, there is no skipping of material of any sort and no progress without mastery.

The other part of the work consists in projects largely chosen by the pupils but directed by the teacher by which children learn to live together while working together. Sometimes there is a debate about what should be done about children riding their bicycles on the playground, or "whether snowballing on the playground should be permitted." There may be dramatization of various episodes in history or of some English play. In brief, there are hundreds of creative activities which children like to do if given a chance.

The Dalton Laboratory Plan is another attempt to individualize instruction which has gained wide favor. The pupil is given his work in a series of related jobs each of which is supposed to cover about twenty days for its completion. These jobs are carefully outlined by the teacher. An individual may choose which of these he shall study and may work it out in the laboratory in any manner he wishes, the only condition being that he must finish one series before he begins a second. For example, if a child has finished work on English in Job I he may not then take up English in Job II but must do his history, reading, etc., in Job I. Furthermore, coöperation is encouraged in the laboratories and children must carefully budget their time. There are conferences with the teachers before, after, or during the laboratory period. In short, whenever conferences are needed they seem to be possible. Children progress at various rates and no job is left uncompleted.

Summary

Near ancestry or family according to the evidence submitted, produces a major share of the differences existing among individuals. Four different lines of evidence converge upon this one conclusion: the inheritance of feeblemindedness and insanity; the tendency for gifted men to be related; the increasing closeness of relationship as we pass up the stairs, cousin, paternal, fraternal, twin; and finally, the tendency for intelligence quotients to remain constant in changing environments and for them to differ rather widely in the same family. Just how great this influence is no man knows. The author has estimated this influence at about 60 or 70 per cent.

Environment, too, has an important share in producing differences among individuals. From it the growing child obtains those broad phases of education and culture which may be called the social inheritance of mankind. The long overlapping between generations makes it possible for *homo sapiens* to transmit a very great deal of this civilization to its junior members. Environment, too, is necessary to develop inherited traits. Without a favorable environment inherited nature remains dwarfed and wilted; with it, this same nature grows and blossoms forth. On the other hand, environment is unable to substitute successfully anything for an inherited lack and its influence is always dependent upon the nature acted upon. It can under certain conditions negate any inherited tendency. The more systematic phases of education represented by the school may thus furnish a suitable environment for developing and educating the original tendencies brought to it. Further, it cannot go.

The more progressive administrators of schools and of school systems have been highly sensitive to the implications coming from the psychological studies of individual differences. Numerous devices to permit different rates of progress for pupils have been tried with varying success. Of these the Winnetka and Dalton Plans seem most promising.

QUESTIONS AND EXERCISES

1. Summarize the findings and the implications of the study of the Kallikak family.
2. State the limitations of such a study, e. g., the method of getting data.
3. Why is the transmission of feeble-mindedness more clear than that of the weakness which results in insanity?
4. Make up a case against the inheritance of genius.
5. Take the most distinguished man in your community or state. Trace back his ancestors as far as you may. What conclusions do you draw?
6. Galton's study of genius is widely quoted. Might not eminent men have exerted an influence to get their relatives into high positions? What do you think of his comparison of the distinguished men of England and America in which he states that the greater opportunities in America give rise to more men of culture but *not* to more geniuses?

7. State clearly the argument for heredity which appears in the discovery of the relation of a large number of the individuals in the Hall of Fame to other distinguished men.
8. With the paternal, fraternal, and twin relationship in mind trace through the argument for heredity which results from this fact.
9. State the main facts concerned with the twins who were reared apart.
10. Just what light does the constancy of the I.Q. throw upon this question?
11. How constant is the I.Q.? Why do those computed from consecutive measures tend to increase towards the end of the testing period?
12. Why is the Wild Boy of Aveyron interesting in this connection?
13. What does the environment contribute in producing individual differences?
14. Just what part can the school play in changing individuals of different levels of intelligence? Do you think the position that those of medium intelligence profit most by environmental influences is well taken? Why?
15. State clearly the position of this book towards the influence of heredity and environment.
16. State and evaluate the various methods which have been used to provide for individual differences.

REFERENCES

"Adapting the Schools to Individual Differences," *Twenty-fourth Yearbook* of the National Society for the Study of Education, Part II, 1925.

Bagley, W. C. "Educational Determinism," *School and Society*, 1922, Vol. *15*, pp. 373–384.

Cattell, J. McK. "A Statistical Study of American Men of Science, III: The Distribution of American Men of Science," *Science*, 1906, Vol. *24*, pp. 732–742.

Freeman, F. N. *Mental Tests*, Chap. XVII, 1926.

Galton, Sir Francis. *Hereditary Genius*, 1892.

Gesell, Arnold. "Mental and Physical Correspondence in Twins," *Scientific Monthly*, 1922, Vol. *14*, pp. 415–428.

Goddard, H. R. *The Kallikak Family*, 1912.

Hildreth, Gertrude Howell. *The Resemblance of Siblings in Intelligence and Achievement*, 1925.

Hollingworth, L. S., and Winford, C. Amelia. *The Psychology of Special Disability in Spelling*, 1918.

Kincaid, Margaret. "A Study of Individual Differences in Learning," *Psychological Review*, 1925, Vol. *32*, pp. 34–53.

Muller, H. J. "Mental Traits and Heredity," *Journal of Heredity*, 1925, Vol. *16*, pp. 433–449.

Odin, A. *Genèse des grands hommes, gens de lettres français modernes*, 1895.

Rosanoff, H. J., and Orr, Florence I. "A Study of Heredity in Insanity in the Light of the Mendelian Theory," *Bulletin No. 5*, Eugenics Record Office, Cold Springs Harbor, N. Y., 1911.

Starch, D. *Educational Psychology*, Chap. VI, 1920.

Terman, L. M. *Genetic Studies of Genius*, Vol. I, 1925.

Thorndike, E. L. *Educational Psychology*, Vol. III, Chaps. XI and XIII, 1914.

Wallin, J. E. Wallace. *Spelling Efficiency in Relation to Age, Grade, and Sex and the Question of Transfer*, 1911.

Ward, L. F. "Applied Sociology," *Influence of Environment*, Part II, Chap. IX, 1906.

Woods, Frederick Adams. *Mental and Moral Heredity in Royalty*, 1906.

Woods, Frederick Adams. "Heredity and the Hall of Fame," *The Popular Science Monthly*, 1913, Vol. *82*, pp. 445–452.

PART III

PROBLEMS INVOLVED IN MEASURING MENTAL TRAITS

CHAPTER XII

INTELLIGENCE AND INTELLIGENCE TESTING

Intelligence is so closely akin to our old friend *general mental capacity* that the one might be taken for the other. In Chapter II we found that general mental capacity is inherited, since mental weakness appears from generation to generation in the same line of inheritance; that the intelligence quotient remains constant from year to year, thus indicating the inadequacy of the environment to affect the inner growth, and that sibs were not so closely related as twins. For all these reasons we concluded that general mental capacity is inherited. These ideas have been further elaborated in our discussion of the disciplinary problems arising out of the mental incompetency of individuals to succeed in the school situation, and in our discussion of individual differences. In the present chapter we shall discuss (1) the nature of intelligence, (2) its measurement, and (3) the uses of tests in the school situation.

INTELLIGENCE

The word intelligence has a wide popular meaning. We say of a man who sees far and wide the implications of certain facts, "He is an *intelligent* man." This man, for example, who foresees the inevitable growth of a city in a certain direction and who buys property accordingly is said to be *intelligent*. Another who goes to the heart of the matter while others are merely shooting at the fringe and who persists in his undertaking until the goal has been reached, we say in a qualifying way "is highly intelligent." On the other hand when an individual responds to a new situation in the same way time after time with little or no change even in the face of evident difference, we say he is unintelligent, a blockhead, a Dummkopf, or something of the kind. Some such meanings as these permeate the word when it is used in its technical sense. Some such meanings must have inhered in the mind of Alfred Binet when he defined intelligence as those characteristics of the thought process which tended (1) to take and maintain a definite direction, (2) to make adaptations for the purpose of attaining a desired end, and (3) to include the power of autocriticism. Other psychologists have emphasized different aspects of the intelligent act, some claiming that intelligence is the capacity to think abstractly; others, the ability to respond to novel data, or to meet new situations, or to adapt one's self to the environment; while another has defined the more intellectual aspect of intelligence as the power of good response from the point of view of truth or fact. Some, even, more facetious than the rest, have said that intelligence is what their test measures. From the schoolman's point of view, perhaps the definition of intelligence as the *capacity to learn* is as good as any other, for whether or not this definition includes all of intelligence, it does include that phase of it which, in the first place, can be demonstrated to exist and, in the second place, is of primary importance for success in school work.

The Measurement of Intelligence

It was this very man, Alfred Binet (1857–1911), who has been called the father of intelligence testing. Father, because he passed down to the present generation a healthy growing child, the intelligence test. Binet worked for many years striving to attain some accurate measurement of the higher mental processes. He felt certain that the followers of Wundt with their careful introspective procedures and reaction time experiments (e. g., a study of the time necessary to press down a telegraph key at the perception of a yellow light) were somehow not getting at the thing in which he was interested; indeed their experiments on acuity of hearing, on the relation between the physical stimulus and mental response (a logarithmic relation was discovered to exist between the stimulus, say a weight, and the response, a consciousness of difference; for example, to tell the difference between two lifted weights one of them must be increased by one-fortieth of its present weight) were, he thought entirely too much concerned with the simpler processes of mental life. He, therefore, devoted his time to attempts at measuring more general intellectual capacities. It is interesting to see him trying this and that method in his attempt to discover a real measure of intelligence. At one time he is at work on the two-point threshold [1] and attention, and at another he is comparing the intelligent and unintelligent in head measurement. Again, he employed palmists to read the palms of individuals and from these readings to estimate the amount of intelligence possessed by them. Only in the giving of little mental problems ("tests" as Cattell had named them in 1890) and their arrangement from easy to hard, did he ever get results sufficiently significant to warrant further investigation. Once he was on the right track he worked diligently and steadily towards the perfecting of his instruments.

Binet called in three teachers, friends of his, to estimate the intelligence of some children. Binet, who took notes on this procedure, found that they soon fell back on the test method. Many of the questions were directly dependent upon the knowledge gained in school. Others were concerning the children's observations of objects in the neighborhood. The teachers, too, because they had no standards of giving or scoring, varied both in their methods of giving and of scoring the tests and consequently did not agree very closely in their estimates of intelligence. Another cause for this lack of agreement appeared in their choice of tests which were chosen in total disregard of whether or not they depended on schooling. The experiment showed Binet that his method of approach to the problem of the measurement of intelligence through tests was one which was naturally employed by untrained teachers, but that their technique needed almost infinite refinement.

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[1] Binet thought that the distance apart on the skin which two compass points had to be moved, before they could be perceived as two, might indicate the amount of intelligence possessed.

You see, Binet was not looking for tests directly dependent on schooling. He wanted to secure tests which were dependent for their answers on the knowledge which children had picked up of their own accord or which all children had received an opportunity of learning. Anticipated here are the later attempts to measure *native* capacity. This is made possible because the individual differences of those subject to the same environment are due to heredity.

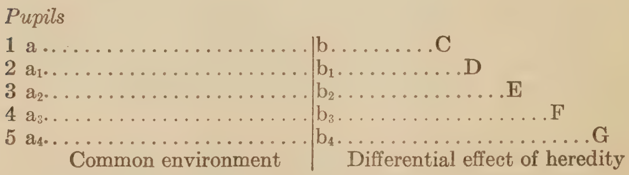

FIG. 42.

Figure 42. illustrates the parts that heredity and environment play in producing the intelligence of the individual. Thus in Figure 42, a–b is common in all the pupils, 1, 2, 3, 4, 5, that is, these five pupils had had an equal opportunity to learn the answers to the questions asked them. But each one was different in inherited capacity. Thus the inherited capacity of number 1 made it possible for him to grow to C when he was surrounded by this environment, while 2's inheritance made it possible for him to grow to D, and so on with the others. It is thus seen that while it is impossible for any test to measure native capacity, a series of tests may point out differences which are due to innate capacity. This very attempt at measuring innate capacity for learning has caused much misunderstanding, for to interpret differences as due to hereditary factors when nothing of the preceding environment is known, is nonsense. Although Binet did not draw sharply the distinction between native and acquired intelligence, more recent writers have done so.

The torch lighted by Binet burned most brightly in America. In France, Binet had been given the problem of distinguishing between the normal and the feeble-minded in the city of Paris; in America, Goddard, working in the institution for the feeble-minded at Vineland, saw in these tests aids in classifying feeble-minded children for purposes of instruction. Some of the tests, however, did not fit American children and so he set out to adapt this newly constructed instrument to American conditions. He, as were others, was immediately confronted with the query as to what is normal. To answer this question he tested two thousand public school children and computed his age standards from the median scores which gave a definite meaning to a normal mental development of each age. In this manner, the first American edition of this scale was constructed. Kuhlman, Huey, and others held up the hands of Goddard in this venture. The interest in it did not blind its users to the defects in this scale. It was soon seen that American children scored too high at the lower end of the scale and too low at the upper end. It would thus appear that a child normal at first became feeble-minded as he grew older. Again, many truly feeble-minded children would escape recognition. To remedy these defects a group of workers under the leadership of Terman attempted to improve the tests in several particulars.

The Stanford Revision. The Stanford Revision is more truly an American product than either of the earlier revisions. The changes are frequent and significant. This test contains 90 tests instead of Binet's 54, while many of Binet's tests were moved either up or down the scale. "Accordingly of Binet's entire 54 tests, we have eliminated three, and relocated 32, leaving only 19 in the positions assigned them by Binet."

The tests were more evenly distributed at each age. There were sufficient tests to have a uniform number at each age from three to ten and a large enough number at the upper age levels. Moreover, the tests were carefully standardized by giving them in a school located in a community in which both parents and children spoke English so that language difficulties could not play a part in the score. He selected the children within two months of their birthdays for his age standards and used a sufficient number (904) to insure reliability at least up to the age of 14. Not only did he correct the irregularities of giving by writing down a standard procedure but also standardized the manner of scoring both by illustrations of satisfactory and of unsatisfactory responses. For these reasons as well as others the Stanford Revision almost means to-day Standard Revision.

The Stanford Revision uses *age* as a basis or a standard. A test is thus located at one place or another because from 60–75 per cent of children at that age pass that test. For example, at five years of age the following tests appear:

Naming the primary colors.

Defining simple words like *chair*, *horse*, and *fork* in terms of use or better.

These tests appear at this age rather than at year four or six because at five years of age from 60 to 75 per cent of children pass these tests. Below are a few other illustrations at different ages: [1]

Year VI

1. Distinguishes between right and left hand.
2. Can recognize that certain parts of a face or picture are missing.
3. Counts 13 pennies without error.
4. Comprehends what is to be done if it is raining when he starts to school.
5. Knows the names of penny, nickel, dime, and quarter.
6. Repeats sixteen to eighteen syllables with no errors.

Year IX

1. Knows the day of week, the month, the day of month and the year.
2. Arranges weights of 3, 6, 9, 12, and 15 grams correctly.
3. Makes change mentally when he is supposedly sent to a store with ten cents to buy four cents' worth of candy.
4. Repeats four digits backwards.
5. Makes a sentence from three words: *boy, river, ball.*
6. Makes three rhymes with words like *day* or *mill* in one minute.

Year XII

1. Defines correctly 40 words arranged from easy to hard.
2. Defines abstract words such as *pity*, *revenge*, or *charity.*

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[1] Terman, L. M. *The Measurement of Intelligence*, pp. 56–61, 1916. Years VI, IX, and XII, Riverside Textbooks in Education. Houghton Mifflin Co.

3. Can trace a path in a circle representing a field with a small opening representing a gate so as to be sure to find a ball of whose exact location he is ignorant.
4. Puts together in one minute, sentences whose words are presented in a mixed order.
5. Interprets fables such as "The Fox and the Crow."
6. Repeats five digits backwards.
7. Interprets the meaning of pictures.
8. Give similarities between three things, e. g., *snake*, *cow*, and *sparrow*.

It is readily seen that once we have these tests thoroughly standardized so that the average child will score at age, we have the ages as points of reference. A child's mental capacity may then be defined in terms of what he scores on such a test. We call, then, the number of years and months he scores on such a test his *mental age*.

Mental Age. Mental age compares the mental development of a child of any chronological age with that of the average child. Thus a mental age of six means the level of mental development of an average child of six. For example, John is nine years old chronologically but when he is given the test for eight years old he fails on these, then when those at seven years are tried he passes three of these, finally the tests at six years are used and he passes all of them. Thus we have:

At year VI—All passed
    VII—Three tests of two months each—six. (There are six regular tests each year from three to twelve and thus each test counts two months.)

The mental age (M.A.) is then six years and six months. This boy, nine years old chronologically, is greatly retarded mentally. His mental growth just equals that of an average child of six and one-half years.

Another child, eight years old chronologically, passes all the tests at seven years, four at year eight, and two at year nine. His mental age then is:

VII—all
VIII—4 tests—8 months
IX—2 tests—4 months
M.A. = 8 years

This child is exactly normal and differs none from the average child.

Finally, a boy six years old passes all the tests at five, all at six, all at seven, four at eight, two at nine, and two at year ten. His mental age then is:

VII—all
VIII—4 tests—8 months
IX—2 tests—4 months
X—2 tests—4 months
M.A. = 8 years and 4 months

It will be observed that here is a boy who in six years of life had grown as much mentally as the average child in eight years and four months. It is quite awkward to say "A boy who is nine years old chronologically is only six and one-half mentally," or "a six year old girl has a mental age of eight years and four months." What we would like to have is some one figure which expresses the relation between these two facts.

Intelligence Quotient (*I.Q.*) The intelligence quotient or, more briefly and familiarly, the I.Q., expresses the relation between the mental age and the chronological age; for, to obtain it, one divides the mental age by the chronological age and multiplies the result by 100, in this manner:

$$\text{I.Q.} = \frac{\text{M.A.}}{\text{C.A.}} \times 100$$

Now let us go back to our illustrations in mental age. The first one has a M.A. of six years and six months and a chronological age (C.A.) of nine years.

$$\text{Then the I.Q.} = \frac{78 \text{ Months}}{108 \text{ Months}} \times 100 = 72$$

The second case works out easily,

$$\text{I.Q.} = \frac{96 \text{ Months}}{96 \text{ Months}} \times 100 = 100$$

$$\text{In the third case I.Q.} = \frac{100 \text{ Months}}{72 \text{ Months}} \times 100 = 139$$

The I.Q. is, then, an indicator of the rate of growth. An I.Q. of 100 means that this child is growing at the average rate; of 72, that he is retarded almost to the feeble-minded group; of 139, that he is growing at an unusually accelerated rate and is undoubtedly as bright as one in two or three hundred pupils. To express this a little differently we may say of the child with 100 I.Q. that his rate of growth is normal; of the one with 72 I.Q. that his rate of growth is 28 per cent below normal; and of the one with an I.Q. of 139 that his rate of growth is 39 per cent above normal.

THE GROUP TESTS

Binet's group of tests are individual tests, by which is meant that one individual at a time is tested. The amount of care which is possible in testing when only one individual is present before you at a time is certainly desirable. But the time to be taken is simply prohibitive when there are a large number of individuals to be tested in a short period of time. On account of this pressure of time there have been developed group tests. These differ from the individual test in that they may be given to a whole class at one time. During the World War a group of psychologists undertook the preparation of tests which would aid the army in discovering quickly individuals of varying degrees of intelligence. The problem of testing individually a million men was insoluble with the men and materials available for work. Otis, then working with Terman in California, had already a group test in manuscript form. These tests were taken as a basis. Others were added and after two or three months of strenuous work there appeared the Army Alpha and Beta, tests for literates and illiterates respectively. These were group tests capable of testing two or three hundred men at one sitting. These tests were very successful in designating those who were so feeble-minded as to be a liability to the army, those who could be used to do simple manual work, and at the other end of the scale, those who would be suitable as officer material. Necessity was instrumental in speeding up the perfecting of the technique of group test construction. Since 1918 group tests almost by the dozen have been constructed, some of which being very useful in detecting intelligence.

Great care has been exercised in making the directions for giving these tests complete and clear. Examples of the tasks to be done are given in the preliminary exercises. In some tests (e. g., Haggerty's, Delta 2, and the National Intelligence tests) fore-exercises are given and checks are made on them to make sure that the nature of the problem is understood. Material is selected for the individual tests which either is independent of schooling or else which all have had an opportunity for learning. Great industry has been used in grading the elements of the test from easy to hard, and to score the tests objectively. Once the test has been made its standardization is as important as it was in the Binet tests. This is done by trying it out on a large group of children and then computing the median at each age. It is thus seen that while the procedure is somewhat different that the age standard as developed by Binet, Terman, Goddard et alia is continued in the group test.

Group tests differ from individual tests in at least one important respect. Few successful group tests have extended all the way from age 3 to the adult level. This is indeed unfortunate. For example, in the study of mental growth we must use one test, say, in the first grade, while we must change to another before the fourth grade is reached. Another change would be necessary at about the eighth grade and still another at the college level. In illustrating group tests for school uses we shall use one for the primary grades, another for the grammar grades, and still another for high school.

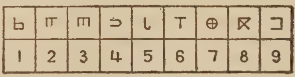
A Test for the Primary Grades. The Pintner-Cunningham Primary Mental Test is a useful test. In the first test of this group of tests there are pictures of several objects, among them a thimble, a needle, and a spool of thread. To the left is the picture of an apron. The question asked the children concerns the marking of the things which mother uses in sewing on the apron. The next test consists of a picture of many sorts of animals some with and some without feathers. The problem is to mark the animals with feathers. There are other tasks such as to mark the pictures of the objects that go up in the air, to choose the prettiest girl, elephant, house, flower, string, etc. Test 3 consists of marking two things which belong together from among four objects presented. Test 4 consists in marking a dress, a hat, a pair of shoes, and a pair of gloves that belong to a picture of a doll, test 5 in identifying among several objects outside a picture the objects which are inside it. Test 6, a picture completion test, proposes as its problem the discovery of the missing parts of a man, a goose, cherries, and a boy with a flag among the pictures of three or four objects, some of which fit and others of which do not. And finally, to pass test 7 a child must draw correctly various types of figures which are presented.

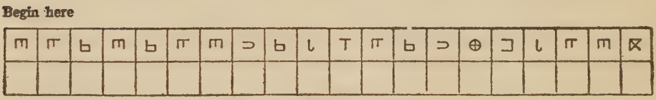
This test is one of several for primary children which does not depend on written language. In a great many instances it is an adaptation of the Binet tests for younger children to group testing conditions. One of the great difficulties in giving a test to little children is to keep them working on the test. Of course, the carrying out of oral directions is a good sign of intelligence in itself.

A Test for Grammar Grades. The National Intelligence Test is divided into two parts—Scale A and Scale B—which together compose a team. This characteristic of possessing two parts is undoubtedly an advantage, for two samples of mental traits are statistically always better than one. It has the further advantage of having three or four forms for each scale, thus permitting retesting without such great practice effect as occurs when the same form of a test is repeated. Fore-exercises, which practice the child in material of like nature to the test but differing in content, are other interesting features of this test. Furthermore, the weights or values for the scores in each test have been statistically determined in the most thoroughgoing manner so that the test well deserves its name. Some, however, have found a too close correlation between progress in school work and increased scores on the National Intelligence Test, thus indicating the dependence of the scores upon schooling.

Scale A. Scale A consists of five tests. The first one is an arrangement of simple arithmetic problems, such as "One quart of ice cream is enough for five persons, how many quarts of ice cream are needed for twenty-five persons?" The second test is made up of sentences with blanks where words belong, the problem being to fill out these blanks correctly. Here is a more difficult one. "Labor unions . . . the right to . . . for higher wages." Test 3 has as its problem the drawing of a line under two words that tell what the thing always has. "Lake, (fish, salt, sand, shore, water)." Test 4 is a synonym-antonym test. Place a D if the words are different and an S if they are the same, e. g., Go—leave; Coarse—crude. Test 5 is a learning experiment. The key and the first line are given below.

KEY





Scale B. Scale B consists of mixed fundamentals in arithmetic, an information test, e. g.—The Arabian is a kind of—Cow Goat Horse Sheep; a test of ability to understand sentences, e. g.—Does money necessarily bring happiness? yes no; a test of analogies, e. g.—Food—Costly, Air—breathe, gas, free, oxygen; and a test of the perception of likeness and differences, e. g.—If the two things in a pair are the same, write S. If they are different, write D.

561—560
70090—71090.

A Test for High School Years. One of the tests most useful in high schools is the Terman Group Test of Mental Ability. There are altogether ten tests in this group varying from the first one, a test of information, best answer, and word knowledge through logical selection, arithmetic reasoning, sentence meaning, analogies, and mixed sentences, to classification and number series. The information test has this element—The turquoise is usually blue brown yellow red. "Best answer" is illustrated as follows:

If a man had a million dollars he ought to
1. Pay off the national debt.
2. Contribute to various worthy charities
3. Give it all to some poor man.

Logical selection may be illustrated by this one in which an individual must underline two words describing qualities which the thing always has.

A gentleman is always considerate educated honest wise witty.

A Test for College Years. Thorndike College Entrance Tests or Roback tests of superior intelligence may be used at this level. Of these I shall illustrate from Thorndike's tests. One must notice their dependence upon the perception of abstract relations for their solution.

"Fill in with conclusions which can be correctly drawn from the given facts in each set shown in the first line.

Given Facts	*Conclusions*	
Z is thicker than X	Therefore Y is—thicker—than	V
H is as thick as Z	Therefore X is	H
V is thicker than H	Therefore Y is	H
V is thinner than Y	Therefore X is	V
	Therefore Z is	Y"

And again we have "Complete the number series

6 11 14 19 22 27 ——
90 85 80 79 74 69 68 63 ——"

Just as in the other tests we have analogies, e. g.,

Sand: glass:: clay: stone, hay, bricks, dirt.

Finally we shall give an illustration of a test of information.

If the two sides of a right triangle are 3 ft. and 4 ft. the hypotenuse is about $4\,{}^{3}/_{4}$ ft., 5 ft., $5\,{}^{1}/_{4}$ ft., $5\,{}^{1}/_{2}$ ft.

What are the mental traits which these tests seem to measure? From a careful analysis of the elements of all the tests which he has illustrated, it seems to the author that the following four items are greatly emphasized:

1. An intelligent individual must first of all be a *good observer.* He must be able to notice similarities and differences among common objects. Unless he has this characteristic he could not have the other three traits.

2. He *must perceive correct relations.* An individual's intelligence varies in proportion as he can perceive more and more subtle relationships. From the perception of a simple relation between an apron and a spool of thread or between a cup and a saucer, through the fact that a finger is to a hand as a toe is to a foot, up to the relation that dead is to lifeless as danger is to peril, on up to the understanding that the same relation exists between yardstick and space as there does between a clock and time, and up and up until a Newton contemplating the setting moon and the falling apple perceives that there is a relation between them.

3. He must *learn and remember.* An intelligent individual learns quickly the names of colors, what animals fly, which ones have feathers, what sort of staff a flag has, what things are beautiful, that an elephant always has ears and a trunk, and that fiction always has imagination and invention. Not only has he learned but he can learn quickly to substitute geometrical figures for numbers or vice versa. Moreover he must *remember*, for if he is intelligent he is called upon to remember that New Year's day is on January the first, that Boston is in Massachusetts, that the humerus is a bone, and that perjury is a term used in law.

4. He must be able from a few stimuli to *get quickly the proper mental set* or adjustment and to *maintain it in an optimum manner.* For example he must be able to get the proper set from

Trees are———than bushes, to recognize that the word is *taller;* or from

The visitor———the child———name

that the visitor *called* the child *by* name. Moreover, as Binet pointed out many years ago, this set must be maintained. Under certain conditions, however, it also seems necessary to shift an attitude quickly. Thus in mixed fundamentals such as:

1	2	3	4
Add	*Multiply*	*Subtract*	*Divide*
$\begin{array}{r}1\\ \underline{5}\end{array}$	2×3	$\begin{array}{r}5\\ \underline{2}\end{array}$	$2\overline{)\;8}$

Many errors occur when the shift is not made quickly enough. Whatever may be the thoughts of psychologists about intelligence and its measurement, whenever they select tests from a great many tryouts, it is seen that those tests which are found to be statistically most accurate do test one's powers of observation, of perception of relations, of learning and remembering, and of taking and maintaining a mental set. From the practical point of view this definition, empirically arrived at, more nearly meets life's conditions than do the definitions which are more brief and logical.

SUMMARY

Intelligence tests arose out of a practical need for the separation of those children who could not succeed in a normal school environment from those who could. The movement was fortunate in having at its head such a leader as Alfred Binet. With a great urge to find out just what a sign of intelligence was, he tried all the methods available—head measurements, physical stigmata, handwriting, two-point threshold, palmistry—all to no avail. But even from the first he had been interested in various types of psychological tests. Most of these were of little help because they were aimed at the simpler mental processes, while he was anxiously concerned with those of a more complex nature. Gradually he was able to try out a number of tests which seem to test general mental capacity until he had tried out and tested fifty-four. At first he simply arranged them from easy to hard without grouping them by ages, but later he grouped them as far as he was able around the ages which they fitted best. Binet's work appealed to workers in America and adaptations were made to American conditions. The best known of these revisions is the Stanford Revision which added many new tests, shifted around individual tests from one age to another and standardized them on normal American children. From the individual tests the step was a short one to group tests which, while not so accurate or so diagnostic as the individual tests, yet do enable us to test large numbers and to classify whole school grades, which procedure would otherwise be impossible. The Pintner-Cunningham Primary Test, the National Intelligence Test, and the Terman Group Test have been cited as fair representatives of useful instruments at three levels—the primary, the intermediate, and the high school. From the inspection of the elements of these tests it was concluded that success in these tests depends upon the ability to (a) observe accurately, (b) to perceive correct relations, (c) to learn and remember, and (d) to take a mental set and maintain it in an optimal manner.

RELATIONS BETWEEN INTELLIGENCE TESTS AND SUCCESS IN SCHOOL

Success in school is directly related to scores on intelligence tests. Both the scores on intelligence tests and success in school are manifestations of what we have defined as intelligence. This relationship holds whether or not group or individual tests are used, and whether the stage of progress of the pupils is at the beginning of school work or near the end of the university course. Below are illustrations from the primary, the intermediate, high school, and university levels.

Primary Grades. The Stanford Revision has been used on many occasions as a means of foretelling what children will do in the first grade of school work. The general agreement seems to be that few if any children (whose mental age falls below five years and six months) can do successfully first grade work, that a few can succeed whose M.A. is 5.8 years, but that it is far better if the child has an M.A. of 6.0 or more to begin with. It would seem then that not six chronological years but six mental years are best for entrance into the first grade.

The following table sets forth this relation rather clearly.

TABLE XXXVIII

Showing how Quality of Work in the First Grade Depends upon Mental Age

(Correlation .725. Quoted from Terman, 1919. From an investigation by Dickson)[1]

			Quality of school work			
	5	4	3	2	1	*Total*
9–6 up					3	3
9–0 to 9–5						
8–6 to 8–11				1	1	2
8–0 to 8–5		1		1	2	4
7–6 to 7–11			5	1		6
7–0 to 7–5		6	10	7	3	26
6–6 to 6–11		9	18	3		30
6–0 to 6–5		6	14	1		21
5–6 to 5–11	3	7	7			17
5–0 to 5–5	4	6	4			14
4–6 to 4–11	8	7	2			17
—— to 4–5	7	2				9
Total	22	44	60	14	9	149

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[1] Terman, L. M. *Intelligence of School Children.* Table 4, p. 46, 1919. Riverside Textbooks in Education. Houghton Mifflin Company.

It is clear from this table that the work of children whose M.A. is below six was ranked very low by their teachers. All the twenty-two pupils whose work is poorest are below six in M.A. On the other hand we find thirteen pupils whose M.A. is below six who are doing average work. There are evidently other qualities at work here than that of intelligence, but the relation is close enough to use the mental test as a basis of classification. The correlation of .725 shows that the average relation is high.

Intermediate Grades. The same conditions hold here as with the primary pupils. By this time differentiation in school work has gone far enough to obtain relations between the scores on the intelligence tests and success on individual subjects. Table XXXIX presents data bearing on both the relation between the average of pupils' marks and their scores on the intelligence tests, and their marks on the individual subjects and these same scores.

TABLE XXXIX

CORRELATIONS BETWEEN SCORES ON THE BINET TESTS AND SCHOOL MARKS

	Burt	*Gates*
Composition	.63	
Reading	.54	.49
Dictation	.52	
Arithmetic (problems)	.55	
Arithmetic	.41	.30
Writing	.21	.08
Drawing	.15	
Handwork	.18	
Reading (rate)		.46
Spelling		.31
Composite Achievement		.54

Success in all school subjects is related to success in intelligence tests but there are quite large differences between the subjects. Composition, reading, and dictation are markedly related to the intelligence tests; while arithmetic and spelling are somewhat less so; with drawing and handwork least of all. The Binet Tests evidently do not test this type of intelligence.

High School. The results here are from group tests which test very nearly if not exactly the same characteristics that the Binet does. Table XL shows the marked relationship between intelligence and school success in high school.

TABLE XL

THE CORRELATION BETWEEN INTELLIGENCE TESTS AND SCHOOL MARKS

	Otis	*Alpha*	*Miller*	*Terman*
All Subjects	.45	.48	.48	.49
English	.47	.47	.46	.44
Mathematics	.43	.51	.46	.47
General Science	.50	.46	.59	.64
History	.26	.32	.17	.41

You will notice a substantial agreement among the four tests in their relation to the marks obtained in the four subjects of instruction and in the average of them all. With all subjects a variation from .45 to .49 would be no greater than the difference between the .49 and the correlation coefficient obtained when calculating the relation between Terman Group Test, say, and the average school marks with another set of pupils. All four of these coefficients were calculated from the same individuals in each case. When different sets of subjects were used we get large differences in the coefficients.

TABLE XLI

Distributions of Coefficients of Correlations between Army Alpha and High School Marks

Coefficients	*Frequency*
.51	2
.49	2
.47	2
.45	2
.43	
.41	3
.39	
.37	5
.35	3
.33	
.31	1
.29	
.27	2
.25	
.23	2
.21	
.19	2
Total	26
Median	.38
Range	.19–.52

Due to variations in groupings, in conditions under which the tests were given, errors in scoring, and in some cases to errors in calculation, there are great differences between the sizes of coefficients.

College and University. The college student has ever been available to students of psychology as a subject of experimentation, so that many studies have been made of the relation between intelligence tests and school marks. The size of these coefficients varies but little from those found in the high school.

TABLE XLII

Coefficients of Correlation between Otis Scores and University Marks

		1922–1923	*Number Cases*	*P. E.*	*1923–1924*	*Number Cases*	*P. E.*
French		.403	339	.030	.347	222	.040
Mathematics		.394	479	.025	.286	134	.053
English		.509	511	.022	.405	325	.032
History		.451	438	.025	.345	167	.046
Chemistry		.335	176	.045	.251	160	.050
Spanish		.391	132	.049	.423	108	.053
Economics		.322	46	.089	.317	177	.045
Engineering		.380	56	.077	.370	41	.090
Geology		.459	135	.046	.216	90	.068
Latin		.387	83	.063	.277	62	.079
Zoölogy					.070	41	.100
German		.615	27	.080	.306	24	.124
All students in all subjects		.524	562	.021	.433	409	.027
1922 1923	First term	.509	552	.021	.361	394	.029
	Second term	.444	546	.023	.402	376	.029
	Third Term	.456	508	.023	.270	347	.033

Table XLII shows that the Otis test is related to school marks in a substantial degree. If we look first at the results of all students in all subjects we see the closest correlation appearing in those marks received nearest to the time the intelligence test was given. This might be explained by the differential rate of mental growth among the students. Furthermore, during the second year a large number of the poorest students do not return, this tending to contract the range of scores. This contraction of range is always accompanied by a lower correlation. Again we have a wide variety of results when the subjects, testers, etc., differ.

TABLE XLIII

Distribution of Correlation Coefficients between Alpha and University and Normal School Marks

Coefficients	*Frequency*
.66	1
.64	
.62	
.60	
.58	
.56	1
.54	1
.52	3
.50	1
.48	3
.46	4
.44	1
.42	2
.40	1
.38	4
.36	1
.34	5
.32	
.30	1
.28	2
.26	2
.24	1
.22	1
Total	35
Median	.41
Range	22–66

If we look again at Table XLII it is clear that the marks on some subjects are much more closely related to intelligence test scores than are others. English, History, and French correlate more highly than chemistry or Latin.

There is a marked resemblance between intelligence tests and marks received in school. The highest of these relations appears in the first grade, probably because little children more nearly than others work as well as they are able. As we pass up the grades more and more factors are introduced which affect school marks. Extra-curricular activities are participated in by some to a very large extent while others avoid them. The curriculum appeals more strongly to one than to another. The teacher's personality also varies in its effect upon two children equal in intelligence. Teachers, too, vary in their grading both among themselves and in the case of each individual teacher's successive marks. It is thus clear that the mark is a composite of intelligent effort and teacher reaction. The fact that intelligence plays only a part in the whole should not blind us to the significance of this part.

The Uses of Intelligence Tests

Once it was discovered that intelligence tests were closely related to success in school, the next step was to use them for purposes of classifying pupils for purposes of more efficient instruction. It will be recalled that intelligence may be defined as the *capacity to learn.* In many cases we find low correlations between intelligence tests and the capacity to learn because the individual is not using the capacity he has. Particularly is this true of very bright children for they rarely ever have been kept even near the limit of their ability. It is evidently nonsensical to attempt to instruct in the same classroom children differing very largely in their capacity to learn. Intelligence tests, then, have offered an opportunity to place together in the same class children with a similar capacity to learn. This has ordinarily been called *homogeneous grouping.*

Usually other factors, such as previous school records and teachers' judgments, have entered into the classification. This type of classification has been most successful with the children of the first grade. Moreover, the children within the grade may be divided into at least two groups.

This homogeneous grouping is a very great aid to the teacher because it permits him to adapt his work to the level of the class to be instructed. The dullest group usually takes the minimum essentials of learning and moves at a slower pace; the middle group does the ordinary work with a richer curriculum; the brightest group advances more rapidly in reading, investigating, and reporting, and in general getting a much more enriched course of study. Mischief-makers are reduced because usually the chief ones are they who either do not understand the explanation or else those who are bored by them. Few are the children who remain problems of discipline after they have material thoroughly adapted to their capacities.[1]

Aids in Selection for Special Treatment of Dull, Border-line, and Feeble-minded. The dull and border-line cases constitute the real school problem, for the feeble-minded rarely ever pass beyond the first or second grades. The intelligence tests are useful here in helping to select those who should be placed in a special class. It is far better to discover these pupils earlier than to let them move upward because of their size or else to get them accustomed to failure. We are thus enabled to classify the children weak in mind so that they may be properly instructed. Some of those who need special class work are merely back in some subjects or other or may be in all subjects due to an accumulation of unfortunate school experiences and will return to the normal classes. Most will not. If those who will not return to the normal class are not segregated they become in many cases serious disciplinary problems. If they are placed in a special class it is well to know that this special class work will be permanent but at different levels of work as the years succeed. It is the intelligence test which can aid us in knowing just which children will probably remain in the special class. Then, too, the tests have aided us in defining more exactly the meaning of feeble-minded. The users of tests have said that an individual whose I.Q. is below 70 is feeble-minded. Children, then, of I.Q. below 70 may be definitely excluded from the public schools. Many are backward in their school work because of some physical disability, and intelligence tests aid us directly in deciding whether or not these are feeble-minded.

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[1] Haggerty, M. E. "Incidence of Undesirable Behavior in Public-School Children," *Journal of Educational Research.* Sept., 1925.

Aids in Discovering the Gifted. Just as we need special classes for the feeble-minded, we need similar classes for the gifted. The dull force themselves on our attention. They almost by necessity have to be cared for. The brilliant, those destined to become leaders, are, we find, taught worst of all. On the one hand, Burt found pupils of I.Q. 85 to 95 the best educated—i. e., they had been brought up more nearly to their mental capacity than were those of any other stage—while Terman finds that the educational quotients of gifted children were about four-fifths as far ahead of the average as were the intelligence quotients and attributes their scholastic retardation to the fact that the superior children had not been granted the promotions they had earned. In attempting to get them into their proper niches extra promotions are sometimes tried and these are better than letting the children remain behind their mental level of development. However, gifted children perceive relations quickly and once you get them settled in one grade they are soon ahead of those of that grade. Intelligence tests have discovered that tremendous differences exist between individuals of the same age and have called aloud for provisions for these unusually bright ones. Tests also have been eminently successful in discovering them. If a child scores low on an intelligence test it may be because he is sick or distracted or failed to coöperate, but if he scores very high there is little doubt of his brightness.

One of the most thoroughgoing studies of gifted children has recently (1925) been reported by Terman in a volume entitled *Genetic Studies of Genius.* All told more than a thousand gifted children were studied, 643 of whom were in a special group. The first problem was one of selection. The children were selected from the brightest in several large California cities. Teachers recommended two or three of the brightest pupils and also the youngest. These were tested by the National Group Test. Those who scored among the highest 10 per cent on the National were then tested with an abbreviated Stanford Revision. And finally, those who earned an I.Q. of 140 on this test were selected for purposes of intensive study. It will be noted that the tests were used as the final arbiter in making the decision as to whether or not an individual was unusually bright. Again, another investigator (Whipple) has demonstrated that tests much better than teachers' estimates select pupils for special classes.

Evidence is accumulating from all sides that teachers' judgments of superior children are limited in their value. It seems that teachers fail to consider the age factor. Sometimes the ability to converse easily is taken as intelligence. One investigator (Coy) finds that about 50 per cent of the brightest students would have been ignored if she had relied on teachers' judgments solely. Another (Terman) discovers that by merely looking up the date of birth and selecting the youngest in any class one can get a better idea of the most intelligent child than by asking the teacher to nominate the brightest member of the class. While still another investigator (Whipple) finds by means of the tests a child with an I.Q. of 167 whom the teachers had entirely overlooked. Then, too, mental tests have been successfully used in Detroit since 1917 to select children who shall be in the classes for the brightest children. In conclusion, tests have given us an accurate definition of brightness. An individual is bright who has earned an I.Q. of 110 or above.

Aids in Educational Guidance. The closer relationship of intelligence tests with some subjects than with others, and the constancy of the I.Q. suggested to several workers the use of the tests as one of the aids in guiding young people into courses in which they are more likely to succeed than they would be by a more random selection of them. One student of the subject found that of those on the lowest fourth of a group test who took algebra a large per cent failed. On many occasions in this book attention has been called to the feeling of inferiority which appears after too frequent failures. It is this educational guidance which we are now considering, not only educational guidance in particular subjects but also guidance as to what college to enter and as to whether to go to college at all. Two illustrations, the one in high school the other in college are, presented below to indicate just how much significance intelligence tests have in prophesying continued attendance in high school or university.

TABLE XLIV

RELATIONSHIP OF SCHOOL SUCCESS TO BINET INTELLIGENCE QUOTIENT IN CASES OF 131 HIGH SCHOOL PUPILS TESTED IN 1916 AND 1917 AND FOLLOWED UP FOR SIX OR SEVEN YEARS[1]

(Proctor, 1925)

I.Q. on Stanford-Binet Scale	*No. Cases in each Group*	*Completed 4-yr. High School Course*		*Left High School to go to Work*	
		Number	*Per Cent*	*Number*	*Per Cent*
125 or over (Very superior)	19	19	100	0	0
115–124 (Superior)	27	26	96	1	4
105–114 (Above average)	24	20	83	4	17
95–104 (Average)	36	27	75	9	25
85–94 (Below average)	22	9	40	13	60
75–84 (Dull)	3	0	0	3	100
Totals	131	101	77	30	23

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[1] Proctor, W. M. *Educational and Vocational Guidance*, Table II, p. 31, 1925. Riverside Textbooks in Education. Houghton Mifflin Company.

Table XLIV shows the relation to intelligence and the time the pupil is going to stay in school. Above 115 I.Q. the dropping out seems to be very little affected by intelligence, but as soon as the intelligence quotients go below 100 there is a noticeable increase in the number of those dropping out. For example, 25 per cent of those just at average drop out while there are 60 per cent between 85–94, and between 75–84, none remain.

If we turn to the college situation, the results are not essentially different.

TABLE XLV

THE RELATIONSHIP BETWEEN SCORES ON OTIS TEST AND THE CONTINUATION OF STUDENTS IN COLLEGE. STUDY COVERS A PERIOD OF TWO YEARS

Intelligence Quotients Derived from Otis Tests	*All Students*	*Those Remaining Two Years*		*Leaving Before Two Years*	
		Number	*Per Cent*	*Number*	*Per Cent*
115–124 (Superior)	158	115	72	43	28
105–114 (Above average)	247	154	62	93	38
95–104 (Average)	103	60	57	43	43
85–94 (Below average)	43	18	42	25	58
75–84 (Dull)	11	2	18	9	82
Totals	562	349	62	213	38

There does seem to be a close correlation between the amount of the I.Q. and success in school work. By taking note of column 3 it can be observed that as we pass down the column a smaller and smaller per cent remain two years. On the other hand, column 5 shows the converse of this, that there is an increasing number of the dull who depart.

The two studies just quoted indicate to us what happens under normal conditions, not what would have happened with guidance. A study embodying this idea of guidance will now be presented. Proctor reports the results of the educational guidance of twenty-two pupils who had been carefully tested with intelligence tests, whose vocational choices had been consulted, whose choices of high school subjects had been obtained and whose work had been carefully estimated by their teachers. These twenty-two were compared with 107 unguided pupils. The most significant differences between the guided and the unguided appear in the number who fail in one or more subjects. Of the guided group 18.2 per cent failed in one subject while 30.8 per cent of the unguided group failed. When we consider those who failed in two subjects not one of these was in the guided group, but 10.3 per cent of the unguided group failed in at least two subjects.

Aids in Mental Growth. Intelligence tests are also used for studying mental growth. By the consecutive measurement of the same children they have aided in the understanding of the direction that individual and group curves take from one year to the next. (See Figure 43.) Intelligence tests have made it clear that the mental development of children is a steady consistent process from one year to the next. Their use in consecutive measurements has overthrown the old idea that there are periods of rapid mental growth at the time of adolescence followed by periods of slow growth. There may be periods of rapid growth but they do not appear during the same year in the life history of any group of individuals. Furthermore, mental growth continues until at least 18 years of age. It is now understood that the apparent cessation of mental growth at 16 years, as given by some authorities, was due to the employment of tests which were too easy. If the tests are difficult enough, the scores continue to increase well on into the adolescent period. Good use can be made of the knowledge relating to the uniformity and continuity of mental development. Courses throughout the high school period can be pitched on an increasingly high intellectual level so that increasingly more complex mental processes may be appealed to as the years increase.

In the second place, the tests have shown, too, that the rate of growth at one age of an individual approximates that of another age, i. e., the measure of this rate of growth, the I.Q., has been shown to be approximately constant from time to time. If a child is bright in his early years he remains bright in the later ones; if he is dull, he remains dull. Growth curves which are initially at substantial distances apart rarely ever cross (Figure 43). This information is of especially great assistance in making adequate

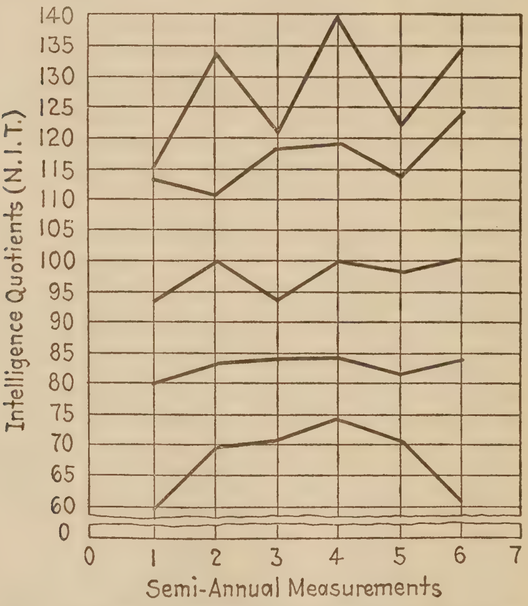

FIG. 43.—Semi-annual measurements with the National Intelligence Tests of five children differing markedly in their initial ability. Note that their curves do not cross.

provision for backward children, for, since they probably will remain backward, cognizance can be taken of that fact in planning out an extended program for their education.

Intelligence and Moral Adjustments. There seems to be some relation between intelligence and morality. The lowest grades of intelligence such as the idiot and the imbecile, have no ability to make moral decisions because they have not the ability to anticipate the results of their acts. They, unless segregated, become a menace to the morals of the community. This much is clear. When we rise a little in the level of intelligence some seem to be able to live outside the clutches of the law and to escape arrest, but many of this border-line level fall into immoral practices and are apprehended. Frequently their acts are stupidly cruel, or again they violate the ordinary moral code in regard to sex or property. The young delinquent is not apt to be very bright (Burt found only 2 per cent above normal). While hardly more than 8 or 10 per cent of the delinquents are feeble-minded, a very much larger per cent are backward. Many of our truants belong in this backward group. We must, of necessity, recognize that many intellectually backward people do their simple work in an honest, straightforward way, and are reliable and steady, while many bright individuals are criminals. But given an emotional disposition which is somewhat abnormal plus a mind which is weak unless the individual lives in an unusually simplified environment he is very likely to become a delinquent.

SUMMARY

The first section of this chapter discussed the growth and development of intelligence tests. It described Binet's attempts and final success in finding some real measure of intelligence and the revisions of these tests in America. Group tests grew out of individual tests because of a felt need for testing large numbers of children in a comparatively short time. Samples of individuals and of group tests for the primary, intermediate, high school, and college levels were presented. An analysis was made of the types of mental processes appealed to in the standardized tests.

The second section was particularly interested in the application of intelligence tests to the school situation. We saw that there was a close resemblance between success in intelligence tests and school work in the primary grades. A mental level of about six years was found necessary for a successful attack upon the work of the first grade. Grammar grade subjects were also correlated with intelligence tests. Some subjects such as composition and reading were very closely related, while others like drawing and manual work showed very little relationship. Similar results in closeness of resemblance appeared also in high school and college. In general while these relationships are not perfect they were sufficiently close to use tests as one means of classifying entering pupils. Nor must we forget that tests are of value for educational guidance since they are markedly correlated with some subjects and not with others; it is possible to direct pupils into subjects which they can master. The large mortality among those of lower than average intelligence attests the need of direction of young people.

Intelligence tests may be very profitably used for homogeneous grouping of children from the first grade through the college. They must always be considered as aids only in classifying pupils, yet properly conceived they give to the principal valuable knowledge in the correct sectioning and promotion of children. Moreover, by giving us a clear-cut notion of feeble-mindedness they have aided in getting out of the ordinary school those whose minds are far below normal. They are sufficiently accurate to determine those who should be placed in special classes. The constancy of the I.Q. gives us little hope that the unfortunate children will ever attain normality, but the records of well-trained pupils even of the feeble-minded level in successfully gaining a livelihood heartens us in our efforts to give them adequate training. Intelligence tests are of great aid in disciplinary cases because they help us in deciding the cause of the dereliction for, not infrequently those of feeble minds are easily led into primrose paths. In the case of those pupils who are failing in their studies, tests help us decide as to whether the lack of success is due to idleness or to the lack of ability.

QUESTIONS AND EXERCISES

1. What is meant by intelligence? Do intelligence tests measure it?
2. How can intelligence tests measure native capacity when all attainment depends upon the coöperation of the environment? Does your explanation seem reasonable to you?
3. Just what did Binet contribute to the development of intelligence tests? Why are Goddard, Terman, and Thorndike thought of as being important figures in this movement for measuring intelligence?
4. What is meant by mental age? I.Q.? Can individuals of the same mental age have different I.Q's.?
5. John, who was born on November 6, 1920, was tested on January 1, 1927, and earned a mental age of seven years. What was his I.Q.?
6. How would you carry on an investigation to show that the I.Q. is constant?
7. Distinguish carefully between an individual and a group test. Which depends more upon speed? Suppose a child showed rather unusual responses; would individual or group test be better to follow up this lead? Which is more reliable? Find out a group test which tests ability all the way from first grade to college. (See Trabue's Mentimeter.)

8. Give a group test to the members of a class, get their school marks, average them and compute the correlation with the intelligence tests. Find out if you can the amount of time each one spends on the average lesson and see if that explains the unusual disagreements between marks and tests.
9. At which level: primary, intermediate, high school, or college, do we find the closest relation between school marks and intelligence tests?
10. What advantages do you see to homogeneous grouping? What disadvantages? What other considerations would arise in addition to the intelligence test scores in forming such a group?
11. How would you use tests for educational guidance? Why could you not completely rely upon them?
12. What is meant by mental growth? What is the shape of the curve for superior children, for average, for inferior children? Could we say that each individual has a different growth curve from any other one?
13. How is a mental test valuable in a juvenile court?
14. Summarize the ways in which mental tests are useful to the (a) teacher, (b) administrator in a public school.
15. Suppose two classes were formed equal in educational achievement. One of these classes was taught by one young woman and gained more than the other class which was taught by an older woman. If the ordinary conditions of sickness and environment were the same in the two groups could you say conclusively that the former was the better teacher? Why?

SELECTED BIBLIOGRAPHY

General References

Ballard, P. B. *Group Tests of Intelligence*, 1923.
Brown, William, and Thomson, G. H. *The Essentials of Mental Measurement*, 1921.
Burt, Cyril. *Mental and Scholastic Tests*, 1922.
Dickson, Virgil. *Mental Tests and the Classroom Teacher*, 1923.
Freeman, F. N. *Mental Tests*, 1926.

Hines, H. C. *Measuring Intelligence*, 1923.

Peterson, Joseph. *Early Conceptions and Tests of Intelligence*, 1925.

Pintner, Rudolph. *Intelligence Testing*, 1923.

Spearman, C. E. *The Nature of Intelligence and the Principles of Cognition*, 1923.

Spearman, C. E. *The Abilities of Man*, 1927.

Symposium. "Intelligence and Its Measurements," *Journal of Educational Psychology*, 1921, Vol. XII, pp. 123–147 and also 195–216.

Terman, L. M. *The Intelligence of School Children*, 1919.

Terman, L. M. *The Measurement of Intelligence*, 1916.

Woodrow, H. *Brightness and Dullness in Children*, 1919.

Woodworth, R. S. *Psychology*, Chap. XII, 1921.

Intelligence Tests and Success in School

Book, W. F. *Intelligence of High School Seniors, etc.*, 1922.

Breed, F. S., and Breslich, E. R. "Intelligence and the Classification of Pupils," *School Review*, Vol. XXX, 1922, pp. 51–56, 210–226. Otis and Terman Tests used.

Burt, Cyril. *Mental and Scholastic Tests*, Section 6, pp. 175ff., 1922.

Jordan, A. M. "Correlations of Four Intelligence Tests with Grades," *Journal of Educational Psychology*, 1922, Vol. XIII, pp. 419–429.

Jordan, A. M. "The Validation of Intelligence Tests," *Journal of Educational Psychology*, 1923, Vol. XIV, pp. 348–366, 414–428.

Jordan, A. M. "Student Mortality," *School and Society*, 1925, Vol. XXII, pp. 821–824.

MacPhail, A. H. *The Intelligence of College Students: A Study of Intelligence as a factor in the Selection, Retention, and Guidance of College Students*, 1924.

Pintner, Rudolph. *Intelligence Testing*, Chap. XI, 1923.

Proctor, W. M. *Educational and Vocational Guidance*, 1925.

Terman, L. M. *Intelligence of School Children*, 1919.

Intelligence Tests and Gifted Children

Gillingham, A. "Superior Children, Their School Progress," *Journal of Educational Psychology*, 1920, Vol. XI, pp. 327–347.

Pintner, Rudolph. *Intelligence Testing*, Chap. IX, 1923.

Terman, L. M. *Genetic Studies of Genius*, 1925.
Whipple, G. M. *Classes for Gifted Children*, 1919.
Yates, D. H. *A Study of Some High School Seniors of Superior Intelligence*, 1922.

Intelligence Tests and Backward Children

Doll, E. A. "The Growth of Intelligence," *Psychological Review Monograph*, 1921.
Goddard, H. H. *Feeble-Mindedness, Its Causes and Consequences*, 1920.
Hollingworth, L. S. *The Psychology of Subnormal Children*, 1920.
Pintner, Rudolph. *Intelligence Testing*, 1923, Chap. VIII.
Wallin, J. E. Wallace. *The Education of Handicapped Children*, 1924.

Mental Growth

Baldwin, Bird, and Stecher, Lorle. *Mental Growth Curves*, 1922.
Brooks, F. D. "Rate of Mental Growth, Ages 9–15," *Journal of Educational Psychology*, 1921, Vol. XII, pp. 502–510.
Freeman, F. N. "The Interpretation and Application of the I. Q." *Journal of Educational Psychology*, 1921, Vol. XII, pp. 3–13.
Johnson, Buford J. *Mental Growth of Children*, 1925.
Terman, L. M. "Mental Growth and the I.Q," *Journal of Educational Psychology*, 1921, Vol. XII, pp. 325–341, 401–407.
Terman, L. M. *Genetic Studies of Genius*, 1925.

CHAPTER XIII

EDUCATIONAL TESTS

Habits of reading, writing, and spelling, of working geometry originals, of translating French, etc., are slowly built up as the results of the functioning of the laws of learning. These habits may be thought of as existing in amount, i. e., the ability to read exists in amount, for some are good readers and others are indifferent, while still others are poor. If habits, sometimes called "functions" in this connection, exist in amount, then if we exercise sufficient ingenuity we can express on some kind of scale these differences in amount, i. e., we can measure the function. It is just this expression of the degrees of amount of a habit which has been attempted by means of educational scales.

The general principles of accuracy and precision so beautifully illustrated in scientific measurements apply as well in the measurement of educational achievement. By accurate measurements we mean measurements of such exactness that if two workers should measure the same facts accurately, they would get the same results, or if the same worker should apply the instruments the second time his second measure would agree with his first. The scientific method is well illustrated by the following story: On one occasion, there was to be measured a very important piece of land. A great deal of money was involved so that it was necessary to get the most trusted surveyor in all that land. One of the points to be determined upon was the position of the corner stone and this, the surveyor undertook as his first task. He made all the measures with extreme care as was his wont. When all the work had been checked, he told his helper to stick down his staff at a designated point and he would find the stone. The helper did so but no stone was found. Like the good scientist that he was, this surveyor went over all the work the second time, checking each measurement with great care but with precisely the same results as the first, so that all the measures were checked up even to the third time. The surveyor then said that the stone must be near that spot and he and his helper dug up the ground near the designated point. In this way they found the corner stone which was a grindstone, the central part of which, being made of wood, had rotted out and it was through this hole that the staff had been plunged on three successive occasions. Such accuracy as was attained by this surveyor may never be attained by those who measure educational products, but they are continually improving their methods of measurement.

Difficulty in the way of Accurate Educational Measurement

The Function is Complex.[1] Suppose we were attempting to measure the trait of handwriting. A very successful scale used the principle of the judgment of general merit to secure the proper arrangement of samples. One sample of the scale was judged to be better than another because its general merit was superior. As any one knows, "general merit" is a very complex function including such habits as letter formation, spacing, quality of line, and various other factors. And even more complex scales for measuring English composition have been built by arranging on a scale samples whose position was determined by their general merit. Even such an apparently simple function as addition has been shown to include a large number of specific habits. Educational products, then, are complex. Recently, as we shall see, attempts have been made to break up the broad, complex functions into narrow, simple ones and to measure these more precisely.

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[1] Thorndike has made essentially the same points in the *Seventeenth Yearbook* of the National Society for the Study of Education, but so well known are these principles among educational workers that they have become current coin.

Zero Points on these Educational Scales have been very Difficult indeed to Determine. Just what could one mean by zero ability in handwriting, or "just not any" of this ability. Experts differ very widely on just what is meant by zero ability in handwriting or in composition. Now if two measures are given of a certain function each starting at a different origin the results will not be the same. All of the scale makers have had before them this difficult problem. Many have attempted to meet it by using the consensus of the opinions of experts as to what zero ability is, and in this manner they have overcome this difficulty as far as practical purposes are concerned.

The Product is Variable. If a child tries as best he can to add rows of nine three-placed numbers he will not get the same number right from one time to the next. An excellent runner may vary from 10.1 to 9.8 seconds in running the 100 yards. In doubtful words, good spellers may not spell the words alike on two successive times. In brief, individuals vary their responses from time to time even though they try to do their best at each time. Now this fact of variability may be the cause of a test's seeming inexactness when the test itself is not at fault.

In summary, then, educational products are more difficult to measure than other types of things because of their complexity; second, because it has been so difficult to determine just where the zeros are, where just not any of the trait is; and third, because human nature varies, thus tending to make educational measures appear more inaccurate than they really are.

TYPES OF SCALES [1]

There are two types of scales (1) speed scales and (2) difficulty scales. In the former the tasks are kept as equal as possible; the score being the number of problems done per unit of time. In the latter the tasks increase in difficulty, the score being the most difficult task which the child can perform.

Speed Scales. Great care is exercised in speed scales to make the tasks exactly equal. In the samples of an arithmetic test (Courtis's) the numbers are so arranged that a child performs about the same arithmetical operations in each problem. In the reading test (Burgess) the problem of getting the paragraphs equal was an extremely difficult one to solve. The author analyzed out carefully the elements which might keep the paragraphs from being equivalent. Complex, abstract, and technical thought was immediately ruled out as well as catches, puzzles, accidental leads, irrelevant dramatic appeals, and such like. Furthermore, such factors as memory-span requirements, attention span, vocabulary difficulty, sentence structure, word arrangement, and such like were to be kept constant from paragraph to paragraph since they could not be eliminated. All of the foregoing work was carried out for one purpose and for one purpose only and that was to determine the amount of relatively easy material a child can read in a given time.

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[1] We shall distinguish between scales and tests here as Trabue has done. The scale is the measuring instrument by which is determined the quality of the work done by the pupil in the test. "The test is the procedure by which one secures a sample of the child's work to be measured on the scale." Trabue, M. R. *Measuring Results in Education*, p. 26, 1924.

The following are examples of such tests and scales as have been described in the foregoing paragraphs.

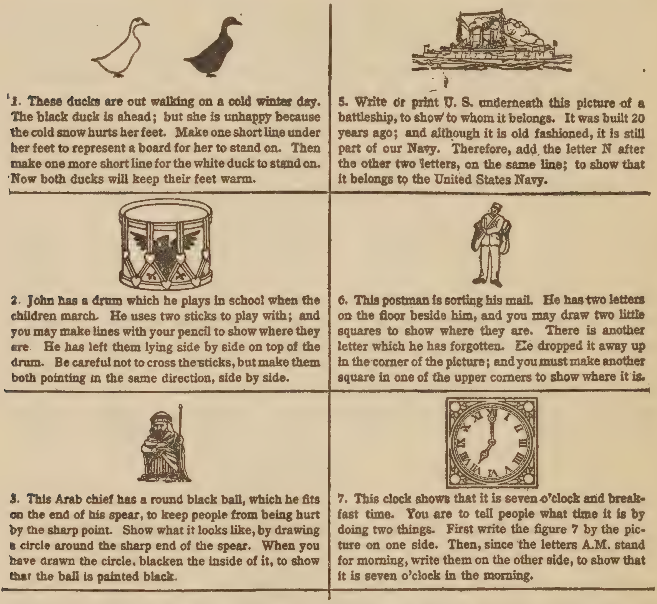
COURTIS RESEARCH TESTS IN ARITHMETIC ADDITION

You will be given eight minutes to find the answers to as many of these addition examples as possible. Write the answers on this paper directly underneath the examples. You are not expected to be able to do them all. You will be marked for both speed and accuracy, but it is more important to have your answers right than to try a great many examples.

339	799	952	937	489	789	872	309
276	584	397	274	877	555	657	964
977	135	535	468	482	342	329	673
861	647	669	836	645	908	794	437
757	642	386	323	761	471	563	338
698	512	974	485	598	896	128	591
269	146	458	357	352	123	856	636
136	699	702	925	431	637	962	704
322	109	397	819	367	254	287	119
—	—	—	—	—	—	—	—

Psychologically, this sort of scale is a measure of the strength of the connection between the situation and the response. If any connection is strong, the response follows promptly and accurately; if it is weak, the time is longer. For example, it takes longer to say the alphabet backward than forward. It has been shown experimentally that if S→R connections are exercised together one of the first signs of learning is a shortened time; and consequently, if one fails to exercise bonds one of the most refined indications of this fact is a slight hesitation in recall, a lengthening of the reaction time. Speed tests and scales, then, measure how quickly tasks known to all may be performed.

Speed scales illustrate probably better than other types of scale the law of the single variable. This law holds that in the measurement of educational products as in other types of scientific measurement there should be only one variable. The rest of the possible variables should be held constant. Ordinarily, there might be four types of variable: *quality*, *quantity*, *time*, *difficulty*.



1. These ducks are out walking on a cold winter day. The black duck is ahead; but she is unhappy because the cold snow hurts her feet. Make one short line under her feet to represent a board for her to stand on. Then make one more short line for the white duck to stand on. Now both ducks will keep their feet warm.

2. John has a drum which he plays in school when the children march. He uses two sticks to play with; and you may make lines with your pencil to show where they are. He has left them lying side by side on top of the drum. Be careful not to cross the sticks, but make them both pointing in the same direction, side by side.

3. This Arab chief has a round black ball, which he fits on the end of his spear, to keep people from being hurt by the sharp point. Show what it looks like, by drawing a circle around the sharp end of the spear. When you have drawn the circle, blacken the inside of it, to show that the ball is painted black.

5. Write or print U. S. underneath this picture of a battleship, to show to whom it belongs. It was built 20 years ago; and although it is old fashioned, it is still part of our Navy. Therefore, add the letter N after the other two letters, on the same line; to show that it belongs to the United States Navy.

6. This postman is sorting his mail. He has two letters on the floor beside him, and you may draw two little squares to show where they are. There is another letter which he has forgotten. He dropped it away up in the corner of the picture; and you must make another square in one of the upper corners to show where it is.

7. This clock shows that it is seven o'clock and breakfast time. You are to tell people what time it is by doing two things. First write the figure 7 by the picture on one side. Then, since the letters A.M. stand for morning, write them on the other side, to show that it is seven o'clock in the morning.

Burgess Silent Reading Test. (Burgess, May Ayres. *Silent Reading Scale*. Russell Sage Foundation, Publishers.)

Let us take Courtis's tests of arithmetic. The time is the same for all, the problems of equal difficulty, the quality or excellence is held constant by considering the number of problems correct. This leaves the quantity, or the number of problems per unit of time, as the variable. In a similar way, when we turn to the Burgess test of reading the time is the same for all (five minutes), the tasks are of as nearly equal difficulty as could be obtained, the quality is held constant by counting only the rights. This leaves the quantity produced in five minutes as the variable. The difficulty tests do not conform so rigidly to the law of the single variable since children can frequently do more than might be expected if they use a very long time. For practical purposes the time has to be limited so that the scores are functions both of the difficulty of the problems solved as well as of the time allowed. In this case we might speak of the *dominant variable.*[1]

Difficulty Scales. Perhaps we can get the clearest distinction between speed scales and difficulty scales by comparing pages 385 and 386 and 388 and 389. For here we have samples of a speed scale and a difficulty scale in the very same sort of educational products: addition and reading. You will note that in the speed scales all of the work is at one level; while in the difficulty scales the tasks increase gradually in difficulty until the hardest are scarcely performed by any pupils in the grade tested. "How hard" now becomes the question, not "how many" which was asked about the speed tests. If addition were a ladder the rungs would be equally distant apart in the speed test and the ladder would be on the level; in the difficulty test, the rungs might be placed farther and farther apart and the ladder slanted against the wall until the child could climb just so far and no farther.

Samples of Difficulty Scales

First sample is two paragraphs of unequal difficulty from the Thorndike-McCall Test of Silent Reading.

Read this and then write the answers. Read it again if you need to.

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[1] Suggested by M. R. Trabue in conversation.

In August, Arthur and his Cousin Kate went in the train to visit their grandfather, Mr. Peters, at Oak Farm. They played in the brook, picked blackberries, and hunted for eggs in the barn. They played with Bob Peters and Nan Allen. Bob was nine years old; Nan was eleven.

5. What kind of berries did the children pick?........
6. Where did they hunt for eggs?..................
7. Whom did Arthur and Kate play with?............

Read this and then write the answers. Read it again if you need to.

THE DESERT

Gaza stands upon the verge of the desert, and bears toward it the same kind of relation as a seaport bears to the sea. It is there that you charter your camels ("the ships of the desert") and lay in your stores for the voyage. . .

The way of preparing for the passage of the desert is this: There is an agent in the town who keeps himself in communication with some of the desert Arabs that are hovering within a day's journey of the place; a party of these, upon being guaranteed against seizure or other ill treatment at the hands of the governor, comes into the town, bringing with them the number of camels which you require, and then they stipulate for a certain sum to take you to the place of your destination in a given time. The agreement thus made by them includes a safe conduct through their country, as well as the hire of the camels. According to the contract made with me I was to reach Cairo within ten days from the commencement of the journey.

27. What animals are used to carry people across the desert?..................................
28. To whom do you apply if you wish to make a trip in the desert?................................

The second sample is from Woody, *Arithmetic Tests in Fundamentals.*

ADDITION

A.	*B.*	*C.*	*D.*	*E.*	*F.*
2	2	15	62	6+1=	21
4	3	4	27		23
	5				34

G.	*H.*	*I.*	*J.*	*K.*
42	26+52=	9	2563	$13.25
13		34	1387	16.50
29		13	4954	17.75
		25	2065	
		17		

L.	*M.*	*N.*	*O.*	*P.*
$6.00	486	${}^{1}/_{5}+{}^{1}/_{5}=$	${}^{3}/_{8}+{}^{5}/_{8}+{}^{7}/_{8}+{}^{1}/_{8}=$	$4\,{}^{1}/_{2}$
2.49	765			$5\,{}^{5}/_{6}$
6.32	524			$7\,{}^{1}/_{3}$
5.57	140			
.99	812			
4.61	466			
	355			
	834			
	567			

Psychologically, the difficulty tests are more related to reasoning and intelligence than to simple habit formation. The mental stretch necessary to perform the more difficult tasks frequently requires the ability to adapt old experiences to new conditions. These tests have been shown to correlate more closely with measures of general intelligence than do the speed tests.

Tests of Diagnosis. The scales displayed thus far are concerned with the more general abilities—not with particular habits; with silent reading and addition—not with sentence understanding or word meaning, nor with carrying or neglecting zeros in addition. In this section the tests set forth are of particular use in analyzing larger habits into smaller ones and thus are of great use to the teacher as well as to the administrator.

By diagnosis we mean the determination of the precise point in the formation of a habit which causes the trouble. This child fails to distinguish between "shall" and "will," that one adds by finding all the combinations which make 10, thereby omitting some of the figures and getting the wrong answer. This student simply fails to change signs in clearing fractions when the parenthesis is preceded by a minus sign. It is for purposes of solving such problems as these which have led to the development of diagnostic tests.

In Arithmetic. Arithmetic lends itself particularly well to the development of diagnostic tests. In the first place arithmetic computation is accomplished by mastering a great number of separate habits which have very little transfer effect from one example to another. Frequently the habits are almost but not quite as disparate as spelling. In the second place there are for the above-named reason a variety of possibilities for making mistakes. In the third place the work is so precise that satisfaction can be quite easily attached to the correct habit once it has been discovered.

In Computation. Two authors (Buswell and John) have arranged examples in addition, subtraction, multiplication, and division in such a way as to give the pupils opportunities for making about all the mistakes each fundamental operation is heir to. There is one page of the thus ingeniously arranged problems for each of the four fundamental operations. There is also a record sheet for the teacher on which can be recorded with a very small expenditure of time the types of errors which are most frequently made. At the top of the teacher's page are a predetermined list of types of possible errors. For example, in addition among those listed are:

A 1 Errors in combinations
A 2 Counting

A 3	Added carried number last
A 4	Forgot to add carried number
A 5	Repeated work after partly done
A 6	Added carried number irregularly
A 7	Wrote number to be carried
A 8	Irregular procedure in column
A 9	Carried wrong number
A 10	Grouped two or more numbers

and eighteen others. The directions are in reference to the list above: "Place a check before each habit observed in the pupil's work." A similar procedure is used with the other three fundamental operations.

Another set of diagnostic tests (Compass) makes an even more elaborate analysis of the habits involved in about 90 per cent of the ordinary arithmetic operations. Altogether there are twenty separate tests, "each covering from one to seven basic arithmetic processes or skills commonly taught in grades two to eight." All types of addition, subtraction, multiplication, and division of the whole numbers and of fractions both common and decimal, of denominate numbers, of percentage, of interest and business forms, and mensuration are included. Moreover, a complete analysis of problems as we shall soon see is also presented.

Suppose we take *addition* as an illustration:

We have given first $\begin{array}{c} 0+2 \\ 1+7 \\ 2+2 \\ \text{etc.} \end{array}$ then $\begin{array}{r} 0 \\ \underline{2} \end{array}$ $\begin{array}{r} 9 \\ \underline{1} \end{array}$ $\begin{array}{r} 5 \\ \underline{0} \end{array}$

as checks on ordinary basic addition facts. Then comes higher decade addition $\begin{array}{r} 2 \\ \underline{20} \end{array}$, $\begin{array}{r} 6 \\ \underline{22} \end{array}$, $\begin{array}{r} 9 \\ \underline{29} \end{array}$, $\begin{array}{r} 9 \\ \underline{20} \end{array}$, $\begin{array}{r} 7 \\ \underline{12} \end{array}$ and $19 + 7$, $12 + 2$, 18 + 8 and so on. Column addition, consisting of rows of single figures but with the number of digits ranging from

$$\begin{array}{rrrl}
 & 4 & & 6 \\
3 \text{ to } 7, \text{ from} & 7 & \text{to} & 3 \\
 & \underline{5} & & 5 \\
 & & & 7 \\
 & & & 0 \\
 & & & 4 \\
 & & & \underline{7} \text{ then is introduced.}
\end{array}$$

Instead of one-place figures there now are presented two-, three- and four-place quantities. Opportunities for making errors in all types of addition are presented in such a manner that the detection of the specific types of errors is almost unavoidable.

Not only do we have the potential errors in subtraction provided for but also checks are made on the meaning of such words and phrases as "minus," "difference," "is subtracted from," "must be added to," and such like. In short, none of the more essential types of habit is omitted and few of the less essential. A complete and thorough diagnostic set of tests is thus provided. No teacher any longer need stay in ignorance of the fundamental difficulties of any or all of his pupils, so that in arithmetic he can know the amount and direction of error and proceed intelligently to the administration of the proper correctives.

More difficult is it to diagnose errors in the solution of problems in arithmetic. Two rather notable attempts have been made in this direction. In the first place, in a problem analysis test Stevenson analyzes problems by asking about each problem:

1. Which of the following facts are given in the problem?
2. Which of the following things are you asked to find out in the problem?

3. Which of the following is the most reasonable answer?
4. Which process should be used in solving the problem?

Four answers are given under each of the questions, the pupils' task being to check the correct answer. It is thus possible by increasing the difficulty of the problem to discover the point at which the pupils' analysis of the problem fails. In the second place the Compass Tests described in the preceding paragraphs devote two tests to this question of problem analysis.

These authors divide the process into five steps:

1. Comprehension (check true statement).
2. What is given (check what is given).
3. What is called for (check what is called for).
4. Probable answer (check probable answer).
5. Correct solution (check correct solution).

The statements in the parentheses are the instructions to the pupils. There are in general five statements under each of the five headings. The problems increase in difficulty and include quite a large variety of problems, sampling as many of the uses of arithmetic as possible. While none of these procedures diagnose as well as the tests for fundamentals yet they do succeed in breaking down the total difficulty into smaller habit systems.

Other Types of Diagnostic Tests. Freeman's diagnostic tests of handwriting analyzing this process into slant, letter formation, quality of line, alignment, and spacing has already been mentioned. C. T. Gray has devised a score card which may well be used for diagnostic purposes. He has samples of handwriting rated on (1) heaviness, (2) slant, (3) size, (4) alignment, (5) spacing of lines, (6) spacing of words, (7) spacing of letters, (8) neatness, and (9) formation of letters. In a similar manner, another student (Paul V. West) has developed a "Chart for Diagnosing Elements of Handwriting." This chart includes a space for rate, quality, letter form, slant, coördination, motor control, spacing, and passage between words.

Diagnostic tests (Charters) for language usage and for composition (Pressey) have been constructed.

In summary, diagnostic tests attempt to analyze the larger functions into more elementary ones, to locate the precise habit which causes the function to be disturbed. It substitutes an analyzed situation for a gross situation. For the classroom teacher these tests are invaluable. They localize errors and furnish specific points at which to apply anew the laws of learning. This location of errors prevents the pupil from having to repeat parts of habits with which he is already acquainted and facilitates his progress by permitting him to put in his time to the greatest advantage so that his progress is more certain, his learning more thorough.

Educational Group Tests for the Placement of a Child within the Proper Grade

Whenever tests are used for the proper placement of children within the grades there are frequently wide differences arising in the various subjects due to a large number of possible causes. In the first place children undoubtedly advance in some subjects much more rapidly than in others. In the second place the standardization of the tests may not be exactly the same. Whatever be the causes a child will score third grade ability in spelling, fourth grade in history and reading, and fifth grade in arithmetic, etc. As long as we have grades this child must be placed in some grade or other. It is just at this point that the group test has stepped in.

Group tests are so arranged that they not only furnish us with rankings in individual subjects of instruction but also give us a total ranking which includes the scores in all the individual tests weighted so that subjects like

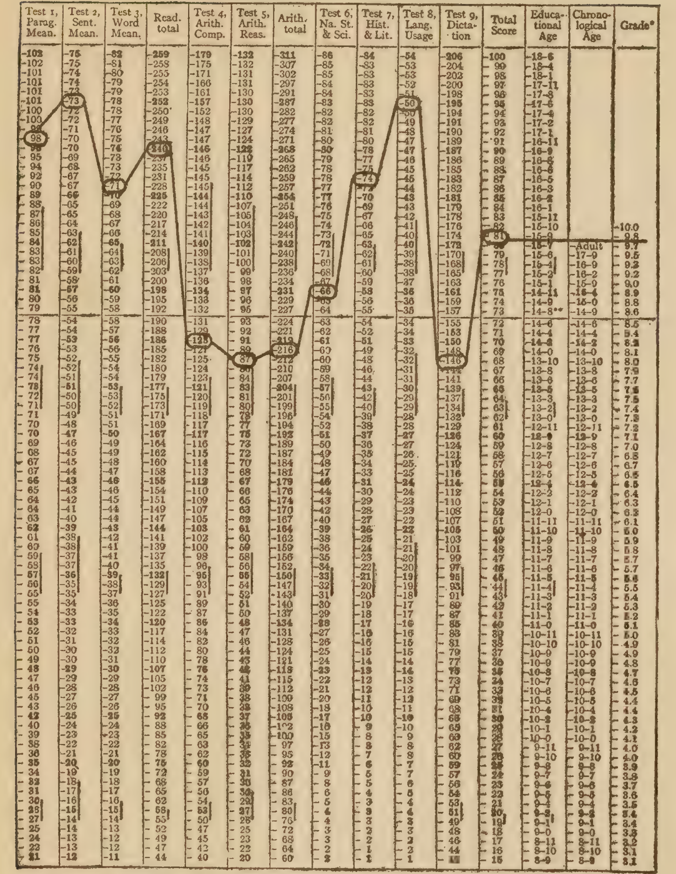

FIG. 44.—Stanford Achievement Test. (Copyright, 1926, by World Book Company, Publishers.)

* Grade defined as in Table 5, Manual of Directions, Revised.
** Educational ages above this point are extrapolated values.
For explanation of vertical bars see Manual of Directions, Revised.

reading and arithmetic will count more than spelling or handwriting.

A conspicuous illustration of such a group of tests is the Stanford Achievement Test. All the subjects of the elementary school except handwriting and English Composition are represented in this test. The individual subjects are very reliably tested by including a large number of items in each test and by selecting the items with care. As a whole the test is almost unbelievably reliable. The correlation between successive givings of the two different forms is never lower than .95 and sometimes nearly .97. The probable error of scores ($= .6745\,\sigma_1\sqrt{1 - r_{1I}}$) when the total scores are compared is never as much as 2 points. It is thus seen that we have here a placement test by which one can place a child among those who are about as far advanced as he so that he may be in a homogeneous group. In such groups the material may be adapted to the needs of all and the rate of learning of all be improved. Nor must we omit to mention the advantages of such a scheme to the teacher. Consider the educational profile of one child, Graph 45. (The lower section of the scores are omitted on account of the difficulties of printing.) A glance at the graph will show that this child is excellent in reading, about up to grade in arithmetic and spelling, somewhat above in nature study and science, and a great deal above in history and literature on the one hand and language usage on the other. The two subjects on which work could be concentrated would be arithmetic and spelling. By applying the Compass diagnostic tests or by a careful analysis of the test scores in arithmetic it would be possible to know exactly where to begin instruction.

Some effort has been directed to the development of prognostic tests, tests which foretell whether or not a student will do well in a course before he takes it. Does this person have mathematical ability, will that one do well in music? The Rogers Prognostic Tests of Mathematical Ability, and the Seashore Tests of Musical Ability have been somewhat useful, but on the whole prognostic tests have proved a disappointment.

I.Q., E.Q., A.Q. A more perfect classification of pupils would be that one in which pupils of the same intelligence and educational achievement would be put together in the same class. Not only would these pupils begin together but they would most probably be near enough together for efficient instruction at the end of six months or nine months. The I.Q., or intelligence quotient, is used to discover a child's rate of growth in intelligence or capacity to learn. The Educational Quotient measures the rate of attainment in the educational process. In the latter case the child's progress in reading, let us say, is compared with that of the average. $\text{E.Q.} = \frac{\text{E.A. (Educational Age)}}{\text{C.A. (Chronological Age)}}$. Suppose that on this reading test the average child of 8 scored 25 points and the average child of 9 scored 35 points. Now if Bill who is 10 years old scores only 35 points, his $\text{E.Q.} = \frac{9 \text{ years}}{10 \text{ years}} = .90$ or 90. A few students of educational measurements have recommended the use of the attainment quotient. The attainment quotient is the ratio of what a child could do to what he does; of his educational quotient to his intelligence quotient.

A.Q. (Attainment Quotient) $= \frac{\text{E.Q.}}{\text{I.Q.}}$. This can be simplified by substituting $\text{E.Q.} = \frac{\text{E.A.}}{\text{C.A.}}$ and $\text{I.Q.} = \frac{\text{M.A.}}{\text{C.A.}}$, which gives $\text{A.Q.} = \frac{\text{E.A.}}{\text{M.A.}}$. With the increase in reliability of both intelligence tests and educational tests there is no reason why this score should not be used more widely. A child whose E.Q. was 100 and whose I.Q. was 100 would have an A.Q. of 100. This would mean that this child had used his inherited capacity to an average extent, i. e., he used what he had. Suppose the A.Q. is 120. This would mean that this child was using his intelligence more than the average child. It may be that he has more zeal or greater energy. At any rate he is using his inherited intelligence well. If on the other hand he scores an A.Q. of 90, this would mean that he had not been stimulated to use the intelligence which he possesses. The scheme has the great advantage of rewarding industry, for if two students, highly different in intelligence scores, would gain the same A.Q., each must work for it.

Uses of Tests in Scientific Investigation of Method. The improvement of the method of presentation of materials to classes depends directly upon careful planning, and testing. Ordinarily parallel groups are formed equal in intelligence and in the subject whose improvement is contemplated. Groups with equivalent knowledge of subject matter are formed by carefully testing them with standardized educational tests. When we have nicely divided the pupils into equivalent groups the same instructor teaches one group in one way, and the other group in quite a different way. At the end of some planned time standard education tests are administered again and the difference between the scores for the first giving and the second giving is taken as a measure of the effect of the method in presenting the material. Methods on so many occasions rest on no more fundamental bases than untested personal opinion. This condition need no longer exist since we understand the technique of parallel groups and have near at hand standardized tests.

SUMMARY

Educational measurements have developed from a desire to make more accurate and objective measures of educational progress. The phase of mental activity measured by educational tests are mental functions which vary in amount. These amounts can be measured. It is thus possible to measure the outward manifestation of a mental function. This, however, is even more difficult than measurement in other sciences because of the complexity of the mental function, its variability, and the difficulty of determining the zero point.

Educational scales measured at first the more general phases of the subject. There were two general types developed: the speed scale and the difficulty scale. In the speed scale the units were of equal difficulty and the scores were given in products per unit of time. In the difficulty scale the units are of increasing difficulty and the scores are in the hardness of problem solved. The speed tests lend themselves more easily to the isolation of one variable; the difficulty test finds it almost impossible to eliminate the time factor. Later the need for more analysis of the pupils' habits was felt and so there was developed the diagnostic scales. These by ingeniously laid schemes place the students in positions where all the types of errors may be made. It is thus possible to discover precisely of what the disease consists and to be in a position to apply the remedy. In arithmetic, handwriting, and language these tests have been especially helpful.

Group tests for the proper placement of students within the grades as well as for the study of their educational profiles have been found to be of value. Such tests have made the educational quotient significant and have furnished possibilities for developing more accurately an attainment quotient based both on intelligence and educational achievement.

QUESTIONS AND EXERCISES

1. What is meant by an educational function?
2. Compare the measurement of a mental function with that of weight. In what respects do they differ? In what essential characteristics are they alike?
3. Distinguish between speed scales and difficulty scales. Why is it that the speed scale may be made to conform more exactly to the law of the single variable? Why is time a good measure of habit formation?
4. Secure some handwriting either from members of the class or preferably from some children. Analyze it into slant, quality of line, letter formation, spacing, and alignment. Rate a sample on each of those functions using 5 as high, 3 as medium, and 2 as low. Make suggestions as to methods of improvement.
5. Give a fifth grade class the Buswell-John diagnostic tests of fundamentals in arithmetic. Make a careful analysis of errors according to the instructions and formulate your recommendations to the teacher.
6. Give the Stevenson problem analysis tests to a sixth grade class. Analyze the problems and report your recommendations to the teacher.
7. What advantages do you see in the analysis of a problem into so many parts?
8. Of what good are the score cards for handwriting?
9. Summarize the main features of the Stanford Achievement Test. Why is it such an excellent test? How can it be used to provide an educational profile?
10. Distinguish between E.Q., I.Q., and A.Q.
11. A child with a mental age of 8 and an educational age of 8 would have what A.Q.?
12. If $\text{A.Q.} = \dfrac{\text{E.Q.}}{\text{I.Q.}}$ and $\text{E.Q.} = \dfrac{\text{E.A.}}{\text{C.A.}}$, and $\text{I.Q.} = \dfrac{\text{M.A.}}{\text{C.A.}}$ show that $\text{A.Q.} = \dfrac{\text{E.A.}}{\text{M.A.}}$.

13. Summarize the advantages of the A.Q.
14. Plan out an experiment to investigate the effect of a great deal of easy reading material on the speed of reading.

REFERENCES

Burgess, May Ayers. *The Measurement of Silent Reading*, 1921.

Gregory, C. A. *Fundamentals of Educational Measurement*, 1923.

Hines, L. N. *Guide to Educational Measurements*, 1923.

McCall, W. A. *How to Measure in Education*, 1922.

Monroe, W. S. *The Theory of Educational Measurements*, 1923.

Monroe, W. S., DeVoss, James C., and Kelly, F. J. *Educational Tests and Measurements*, Revised and Enlarged Edition, 1924.

Seventeenth Yearbook of the National Society for the Study of Education. Part II, Chaps. I and II, 1923.

Thorndike, E. L. *Introduction to the Theory of Mental and Social Measurements*, 1913.

Trabue, M. R. *Measuring Results in Education*, 1924.

PART IV

PROBLEMS INVOLVED IN LEARNING HABITS OF CONDUCT

CHAPTER XIV

PROBLEMS OF SCHOOL DISCIPLINE—THE MALADJUSTED CHILD

In its broader aspects we may conceive of discipline as the organization of his character traits in such a manner that an individual is able to make an adequate and effective adjustment to his environment. We say of such an individual: "He is reliable. He keeps control of his impulses. He never flies off at a tangent. He is dependable. He has a well-disciplined mind." From the point of view of a broader conception of school and of life we are greatly interested in the study of personality from the standpoint of its adjustment to social conditions. Particularly intriguing in this connection is the study of the causes of the failures of individuals to adjust themselves adequately to life's conditions. Furthermore, the histories of the development of certain types of insanity frequently find the exciting causes projecting into childhood. Thousands of persons suffering from acute mental anguish undoubtedly owe their present condition to some terrible emotional experience which, for some reason or other, could never be integrated into the total personality.

More teachers fail in their work from their inability to manage the disciplinary problems than from any other cause. Now in most schools the trouble arises because of the lack of social education in a few members of a class. Some of these have developed antagonistic attitudes towards the teachers, the school, towards their parents, and towards any and all who have attempted in anyway to thwart their desires. Like Ishmael of old they think that every man's hand is against them and that their hands are against every man. Others, even more difficult to direct in a constructive way, take a defensive attitude towards their environment, withdraw into themselves and live within their own fancies. Still others develop the pernicious habits of giving excuses to save themselves from blame or of taking refuge in attainments in the realm of fiction. In all these cases, children fail to meet life's realities. In these conditions appear the need for developing responsibility in school children, for developing the right attitude towards *others*, towards *property*, and towards *authority*. Discipline thus conceived consists in developing a thoroughly socialized individual.

Some Causes of Abnormal Behavior

There are two types of causes which are generally recognized as affecting abnormal behavior: (1) predisposing causes, and (2) exciting causes. Predisposing causes such as hereditary nervous instability, adolescence, death of loved ones, syphilis, and alcohol, we shall not consider at any length although they frequently give a background for the picture of abnormality which we are studying. But original weakness may not manifest itself unless some *exciting* cause conquers the individual. These latter constitute the data of this chapter. It is our position that the teacher should do all in his power to prevent the appearance of causes of mental maladjustment. He should help the child conquer his difficulties by (1) recognizing the early symptoms of serious difficulties and reporting them immediately to a physician, (2) by possessing sufficient knowledge about the nature of abnormal manifestations of personality to aid the child, when the causes are not too complex, in regaining mental health, and (3) by being able to carry out accurately the instructions of a psychiatrist in case treatment is undertaken.

Causes of Mental Maladjustments in Children

The causes of mental maladjustments are probably not exactly the same in any two individuals, but there are certain ones which, when operating under similar conditions produce about the same results. There is generally some emotional difficulty which causes the trouble.

The following constitute a partial list of causes of mental maladjustments:—

I. Hostility, ridicule, or indifference, real or imagined, of adults or associates, lead to a feeling of *inferiority* and a thwarting of impulses and desires.

1. Feeling of guilt because of sex delinquencies.

2. Organ inferiority: a facial scar, enuresis, etc., may lead to a feeling of guilt or shame.

3. Much coddling by too fond parents who prevent the boy's or girl's participation in the social affairs of the community. The boy gets the reputation of being tied to his mother's apron strings.

4. Failure in school with attendant ridicule of the other children.

II. Undue emotional stimulation.

1. Some terrible emotional shock usually of fear may so unnerve an individual that he becomes extremely *excitable.* E. g., a boy about five years old was so terribly frightened by an episode with a mad dog that he developed stuttering.

2. Nervous parents or relatives.

3. Continued overexcitement over a long period of time. E. g., daily attendance on movies.

III. Bad home conditions in general.

1. Parental disagreements.

2. Parental separation, particularly if child is strongly attached to each.

3. Continual worry by the child over financial matters.

Physical disabilities do not seem of themselves to be a cause of mental difficulties. Blind individuals for the most part have the kindliest attitudes towards others because of a continual kindly treatment. What causes the emotional difficulties seems to be the attitudes which others show towards the individual or which he imagines that they show. Bagby gets at the root of the matter in his formula:[1]

hostility
"Qualities—ridicule—ideas of inferiority—defense
indifference—fear

Interpretation: The individual has certain qualities to which his associates react with an unfavorable attitude. To this attitude on the part of others the individual reacts with ideas of personal inferiority and fear. The fear tension motivates reduction habits of thought and conduct." By "reduction habits" is meant habits by which the tension aroused by the fear state is reduced. Children differ widely in their manner of response to these troublesome conditions.

The Aggressive Attitude. If a child can maintain an open combative attitude towards any one or several of these difficult situations he may come through unscathed mentally. He may fly into a rage with his parents and have it out with them then and there. He may leave home, take his physical troubles to a physician, and get into a dozen fights with those who attempt to tease him. On the other hand, he may be unable to cope with a combination of these troubles. A child may also realize and accept his difficulty and face it with but little emotional fervor, and thus may conquer it.

Defensive Attitudes. In case he cannot conquer or make headway against these mental hazards he may assume a defensive attitude. He may be ashamed to talk out his difficulties because society frowns upon them so darkly.

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[1] Bagby, English. *The Psychology of Personality.*

Retreat from the reality of life seems to him the only way to live in peace with himself and to fulfill the desires which are so impelling. This retreat relieves the tension in which he finds himself by draining off some of the energy, bottled up on account of an impossible situation, into a less troublesome channel.

Daydreams. The child may under such tension resort to daydreams. Now as in all the remainder of the mechanisms of escape from reality this particular one when indulged in occasionally is not harmful. The little child in need of a companion to play with may use a Teddy bear as a child and carry on a conversation with it or even in some cases may develop imaginary playmates. Normally as children grow older they look more rationally at life until the age of adolescence. Here again we find a great many fancies and imaginings. These conditions are normal and are to be expected, but when a child begins to substitute daydreaming for reality, when he finds no way for gaining his desires but through daydreams, then the danger begins.

A good illustration of a case of childhood daydreaming which lasted from the third or fourth year up until twelve or thirteen years of age is given by Green.[1] This little girl (M. S.) was an only child and up to the age of three had very few companions. One Christmas, M. S. was taken to a neighboring town where she met a family in which there were a large number of children. They made much ado about M. S. who enjoyed this attention very much. After this an imaginary child, bearing the last name of the family just referred to, was built up in the child's imagination. It wasn't long before there came a whole "nation" to substitute for this one person. At first the imaginary child was the queen, but soon M. S. decided that she herself was to be queen, so that she arranged a coronation ceremony for herself in the garden. She made a crown of clover blossoms and proceeded with the coronation ceremony. The "queen" decided to call these people the "Imaginary People" and to call herself the "Queen of the Imaginary People." This pleasant retreat from reality continued for several years.

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[1] *Psychoanalysis in the Classroom*, 1922.

This daydream appeared to have begun because a lonely little girl had suddenly the joyful experience of association with children of her own age and then, the utter loneliness consequent upon the cessation of this companionship. The fantasy was continued because M. S. did not find social satisfaction among her fellows. She found considerable difficulty in expressing herself at all well, took reproof rather too seriously, and was somewhat awkward and diffident in manner. For these reasons she was not appreciated by her fellows as much as she would have liked and found existence more bearable by preoccupying herself pleasantly in the realm of fancy.

This illustration emphasizes some of the pertinent characteristics of daydreams. First, they are more pleasant than the reality which the individual enters into. Secondly, they are substitute types of reaction. They take the place of what on many occasions would be a more wholesome type of reaction, i. e., a facing of a bad situation and the overcoming of it in some way or other. Thirdly, in them appear the most urgent wishes and desires of the individual very little covered up by any sort of subterfuge. And fourthly, they frequently are expressions of thwarted desires. The following types of daydreams are excellent illustrations of thwarted desires.

The *Conquering Hero* type of daydream, sometimes called the Fantasy of Grandeur, is one of the most common types. Wouldn't it be great to perform some brave deed and on returning home find the town all waiting to welcome one with a brass band? But there is no chance of such an occurrence so that an individual dreams of himself as a real conquering hero. Young boys about 12–14 years must do a great deal of this imagining, for in books most popular with boys this "hero stuff" plays an important part. In the examination of hundreds of books most interesting to boys it was discovered that this one thread runs through most of them whether the scene is laid on the outskirts of a battle, in scouting among the Indians, or on the field of sport. Consider the following book, *The Scouts of the Valley*, written by Altsheler, one of the most popular present-day writers of fiction for 10–13 year old boys. In the frontispiece, we have a picture of a gloomy forest, a wounded man fighting for loved ones, women and children frightened, bedraggled, and downcast. The hero is strong in muscle and accurate of movement, for he can "bring the paddle into the boat, grasp the rifle, and carry it to his shoulder with a single continuous movement." He was born and bred in the forest. "He was the great picture of fact, not of fancy, a human being animated by a living, dauntless soul." This hero is unafraid amid dangers. On one occasion our hero finds the Indians on the point of rising up against the whites. All the party is captured except the hero, who, by craftily laid plans and unexcelled courage, succeeds in freeing one after another of his comrades until he has the Indians so mystified that they attribute these liberations to the "Evil Spirit." The hero warns the settlers, helps to protect the women and children, receives the plaudits of his superiors, is captured and afterwards released, and in general comes out victor. The "Conquering Hero" element is so patent in this substitute daydream that further comment is unnecessary. The author knows at least one grown-up who all through his high school days and even through and after his college days frequently thought "It is the ninth inning; the score is 3 to 2 against us. There are men on second and third, I come to bat and drive out a two bagger. The crowd went wild."

Strange as it may seem an individual may gain a certain prestige for himself by playing the rôle of the *suffering hero*, for, in this manner, he gains attention to himself in a favorable way. A young girl when scolded by her mother would sit near a railroad track and imagine how her mother would feel if she should come out one day and find her daughter all mangled by the train. Then her mother would feel sorry. Young adolescents at some real or fancied jilting by those they love frequently dream of committing suicide and of the consequent regret by their sweethearts. Pouting children are sometimes playing this part and thus gain attention to themselves. During the period of adolescence the repressed sex desires in many instances build up very elaborate love fancies.

Sufficient illustrations have been furnished to indicate the universality of daydreams. When indulged in to a certain extent they are most wonderfully stimulating, but when they become a substitute for reality, a gentle retreat from the rough reality of life, they become most pernicious. Particularly susceptible to this type of daydreaming is the adolescent, who finds at this threshold of adult responsibilities the going rather rough. The all-important sex urge by necessity seems to be an enhancer of daydreams.

When daydreams are completely substituted for reality, when an individual begins to live completely in his fancies we are in the realm of insanity. One of the most common types of insanity is that which appears at the age of puberty or thereabouts, dementia præcox. The most characteristic responses of an individual thus affected is an inlook rather than an outlook, an apparent obliviousness to surroundings, a "shut-in" personality, a person withdrawn into his own daydreams. An individual may be going along doing his ordinary work in an acceptable way when he begins to lose interest in external reality, gets careless of his clothes, and may become dirty in his habits. This is the end product of the undirected daydream, the daydream raised to the *n*th power. Thus Mona Lisa looks out of her picture vacuously smiling, not at you nor with you, but at her own fancies.

Daydreams constitute a retreat from reality. Because an individual is afraid, or ashamed, or unable to gain his desires, or because he is defeated in his attempts or thwarted in his desires, he retires into daydreams as to a pleasant retreat. This condition is apt to put him out of touch with his fellows and with his teachers. It makes an individual very difficult to reach because he seems to have lost interest and is apt to assume a negative, stubborn attitude towards all requests for coöperation.

Compensation. Another type of substitute for reality is the mechanism of *compensation* or overcompensation for some weakness either organic or mental. All are familiar with the coward who talks loudly and blusteringly but who is merely overcompensating for the fear deep down in his being. The young boy acts tough to prevent his comrades thinking that he is a weakling which he really is. The younger brother swears more loudly than the older one to gain attention and notice. The university student with little or no social background develops into a snob as a compensation for his fear that someone will discover his weakness along social lines. Some have even suggested that the exaggerated swearing and smoking of the modern girl is a compensation for her feeling of inferiority.

Adler and Morton have greatly emphasized the influence of organic inferiority in compensation. The child has some organic weakness which he tries to hide by an exaggeration of some trait which covers up this weakness. Thus an adolescent boy may compensate for his general weakness by studying hard and leading his class. Sometimes a boy with a twisted leg will enter into escapades which are highly exciting as an escape from his thought of his own inferiority. That is the point. It is not so much the actual inferiority as it is the thought of inferiority. One of the most potent forces for producing this mental state is ridicule by either parents or comrades. Adults somewhat accustomed to sharp criticism and more or less impervious to the satirical sallies of their friends do not realize what tremendous harm ridicule may do to the growing child whose personality is as yet in the formative period. Teachers should never permit a class to ridicule a child on any occasion and he should be the last one to join in this type of mental thrashing. Children at times suffer unheard of horrors because their mates ridicule them. Sex matters at about the time of adolescence are frequently *veræ causæ* of this feeling. Frequently he who indulges in secret vice may worry a great deal about his possible loss of manliness and may compensate for his weakness in an exaggerated emotional outbreak. These explosions may be harmless or they may lead individuals into many types of adolescent delinquencies such as stealing, lying, running away from home, and in raising disturbances in general.[1] These children so developed may become sullen and insolent and grow to resent criticism in all forms. Furthermore, at the period of adolescence there may appear times of negativism, of feeling that all is wrong, that whatever is, is wrong. Not infrequently these are merely outbursts or compensations for a feeling of helplessness at this period of transition from child to adult.

Whatever the cause, whether arising from some slight by his comrades, from some sarcastic remark of the thoughtless teacher, from the too difficult arrangement of the subject matter whereby the pupil fails year after year, whether it is a true or an imagined cause, in these or in some other way the child develops a feeling of failure, sometimes of utter hopelessness to which he reacts in the only way he knows. He covers up the weakness by means of some strong point which he possesses, by the withdrawal from reality into daydreams, or merely in seclusion, or in some other way. The difficulty arises because he dodges the actual weakness and frequently fails to face the difficulty squarely and solve it. Life is then always a compromise.

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[1] See Healey, William. *The Individual Delinquent*, 1924.

The case of Mildred[1] illustrates this whole matter of feeling of inferiority and attempted compensation so that I shall quote it at some length. At the time the study began Mildred was a tall, stoop-shouldered girl of 12 years. She had attempted school first in a private school which reported after three or four years that it was unable to help Mildred further, then transferred to public school, she had been put back and back until at twelve years of age she was in the first grade.

She seemed totally discouraged and entirely uninterested in her school work and displayed a type of withdrawn attitude suggestive of dementia præcox (see Chapter I). In the investigation of her case the psychiatric, psychological, and other social workers discovered that her family was having great difficulty in making two ends meet because of the continued drinking of the father and his consequent inability to hold any job for very long. Furthermore, Mildred herself had been a source of continued anxiety and worry. The mother had gone from one to another of Mildred's teachers begging them to give her more attention and had even offered to pay extra for this service.

Mildred herself was a victim of congenital syphilis and had undergone long treatment for it. In the second place she suffered from enuresis, which was a source of much worry to her and of a feeling of shame. Moreover, she slept with a smaller, more healthy sister who, tormented Mildred by calling attention to her low position in school and to her own satisfactory progress. This trouble did not engender any love between the two sisters so that they quarreled and even fought on occasions. Briefly, we have here a thoroughly discouraged, highly sensitive young girl of average intelligence whose home conditions were very unpleasant, whose school conditions were about as bad as one could imagine, and who though organically sufficiently strong, yet suffered from embarrassment due to the persistence of enuresis and to the anxiety engendered by attendance upon a free clinic for the painful injection of medicine the result of which she did not understand.

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[1] One of the three cases reported in *Three Problem Children*, 1925.

About the only compensation that she had for this feeling of inferiority was her absorption in painting, sewing and making things for her little sister and in playing with children of her own age after school.

The treatment in this case is suggestive. "The central problem was therefore that of restoring hope, self-confidence, and self-esteem, while at the same time every possible external lever was being applied to lightening the load." This consisted of, (a) sympathetic understanding by the social workers who trusted her, (b) of the changing of home conditions so that Mildred would not have to sleep with her sister, and so that Mildred would be treated more normally at home, (c) in providing opportunity for the growth of personality along recreational (e. g., Scouts) and informational activities. On one occasion the social worker showed Mildred a handmade pendant which was evidently pleasing to the child who was later taught to make them for herself. Her pendant attracted so much attention at school that several others wanted one; so that Mildred made several for her friends. This was an important step in regaining her self-confidence. To this child, before so conscious of her inferiority, the creating of such a furore among her companions must have been a source of distinct satisfaction and a lessening of the state of tension produced by former ridicule. And probably most important of all, (d) providing for tutoring in school work and for a more sympathetic treatment of her case at school. Happily the results were all that could be expected, in that Mildred was rapidly promoted in school, and regained the cheerful happy outlook on life which she had enjoyed before entering school.

The rôle played by the school in accentuating these unfortunate conditions cannot pass unnoticed. The first school seems to have been either totally ignorant of the modern knowledge of diagnosing errors of reading or else did not try to improve the child's conditions in reading. The second did exactly the worst thing that could have happened to a highly sensitive girl like Mildred, i. e., demoted her to the first grade among children half her height and half her age. Probably in no way can the feeling of inferiority be increased more than in providing situations in which a child not only fails, but continues to fail.

Rationalization. In rationalization an individual excuses himself for a fault or condition which he is unwilling to confess and thus "saves his face." Morgan has stated this quite clearly—"Inventing an excuse for doing the thing that we want to do, and covering up the wish by presenting the excuse as the real reason." Some years ago the writer came across a most perfect illustration of the use of rationalization. A young man of much more than average intelligence would persist in being late to class time after time, not once, but a dozen times. The young fellow seemed to worry a little about it, for each day he would present me with a perfectly plausible excuse. He was sick that morning, he had a headache, he simply couldn't get his breakfast on time, his roommate didn't wake him up, etc., ad infinitum. But he never failed in having a plausible excuse. Now as a matter of fact, for some reason or other this young man was organically lazy, so lazy that he simply hated to get up in the morning, that he greatly disliked to work at anything for any length of time. At the same time he disliked admitting these faults and so he rationalized.

Many of the so-called reasons which normal individuals give for their actions are hardly more than rationalizations. "Why are you a member of the Republican or Democratic party?" "Well, I believe in its (no matter which) principles." "What are its principles?" "Well, you know they believe in the protective tariff, in internal improvements (at least they did)." And so it goes with a string of perfectly plausible reasons none of which is more than partly true. The real reason of course is that he was born of Republican or Democratic parents in a Republican or Democratic state. Even scientists who are reputed to have "clear, cold logic-engines" for minds are not entirely free from this pernicious form of thought. Let one of them convert one of his favorite hypotheses into a theory and it becomes his to *defend*, to offer plausible reasons for believing it, to see very few if any exceptions to it and hold to it in spite of apparently (at least to anyone else) insurmountable difficulties. Of course some scientists have been known to carry a notebook merely to note down exceptions to their theories for fear that they would fail to remember them.

Nor do children escape this process of rationalization. Indeed on many occasions they are unwittingly taught this process by their elders, who may punish them severely for certain minor infractions of the social code unless the children can give a plausible excuse for their actions. Like the student just mentioned in the foregoing paragraph, they are asked rather abruptly why they were late, why they did not prepare their lessons, why they lost their caps. Now frequently they do not know, but since an excuse is demanded they procure one. Furthermore, they are often afraid to tell the real reason, or ashamed, and so they get a *plausible reason.*

Probably no one element is more important in moral action than the willingness to face squarely the results of one's own acts and the moral fiber of taking the consequences. Teachers should teach pupils above everything else to give the real reasons, and should reward openness and thoughtfulness above all other things.

When these "reasonings" become so deep-seated that the individual himself is deceived, when he accepts these rationalizations as true, we have cases of insanity. Hart explains this nicely: "Thus, the lunatic who is firmly convinced that his wife is seeking to murder him, will distort the meaning of everything which happens until it is brought into harmony with his dominating delusion, and capable of being used as a pseudo-logical prop. If his wife is solicitous for his welfare, her behavior is regarded as a cloak to conceal her real design; if she treats him badly the evil intentions are clear, if she gives him food it is obvious that she proposes to poison him, if she does not it is equally obvious that she hopes to undermine his health by withholding the necessaries of life." [1]

Projection. Painful emotions are also avoided by the process of projection or blame. This process differs from rationalization only in emphasis. There are in both conditions a painful emotional condition which the individual is unable or unwilling to face squarely so that he feels in a high state of tension. He feels the need of relieving this tension in some way. In the first case he gives a reason; in the second, he projects the blame for it on some other individual. Now it is apparent that the reason given might relate to some other person or thing so that projection might fall as a subhead under rationalization. The classification makes little practical difference, but the conditions are important.

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[1] Hart, Bernard. *The Psychology of Insanity.*

The slang phrase for this manner of reacting in the army during the World War was "passing the buck" for there was always a subordinate who could be blamed for the misdeeds of any officer, commissioned or noncommissioned. This process is one of the most common methods of "upholding one's dignity." The football player makes a silly, senseless play and is taken out of the game. He comes limping in, thus putting the blame on his "game" leg of which in the meantime he had not been thinking.

Young children early learn to get out of an emotional difficulty by laying the blame on someone else. Try your best to get at the bottom of a schoolboy fight and you are met with incriminations on either side. "Bill hit me first." "Sam made a face at me." Each blames the other. Of course, it may be that both are responsible, but somehow each is afraid of being punished, of being reacted to in a scornful way so that each one strives to get approval by blaming the other.[1] Teachers themselves, on being asked why their pupils have not made better progress in their subjects frequently blame the teachers in the previous grade, and they in turn blame those of the preceding one, until the first-grade teacher, more hard put to it than the rest to find someone to blame, blames the fathers and mothers who sent such children to the school to be educated.

This pupil who fails in a course blames the teacher or the school or else the principal for his own deficiencies in knowledge. An individual who failed on one course after another had a formula which he always used, "he done me dirt," which he applied to each teacher whose course he had failed. Thus one student who finds himself in an unfortunate position which brings a certain amount of criticism upon himself, sinks blissfully into daydreams; another may compensate for this loss of prestige by overemphasizing some trait in which he is successful; still another gives a glib explanation of it which by no means explains the conditions; while still another lays the blame upon someone or something else. They are all ways of responding to annoying situations by various trials and errors; they are all attempts to save their faces; and to avoid accepting honestly the blame for their misdoing.

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[1] Bagby, English. *The Psychology of Personality.*

This mechanism of blame may take a rather curious turn in abnormal cases. One case, a rather large middle-aged woman, complained to the police that she was being followed by some strange-looking men. The police on investigation found no one at all that would answer to the woman's description. She then wrote to the chief of police, day after day, letter after letter, entering her complaints. She kept this up until she was apprehended, shown to be insane and sent to an asylum. The author's observations of this case was of a rather large middle age woman gesticulating madly and almost shrieking that there were men secreted in the cellar of her house, who by means of cunningly laid electrical devices were causing her no end of pains. It is probable that this woman was suffering from "old maid's insanity," i. e., from the disappointment that no men were actually paying attention to her and in spite of her general demeanor was harboring a wish that they did. Frequently such projection does consist in projecting upon another a secret wish which the individual is unwilling to harbor.

Identification. Another means of escape from the feeling of inferiority is by means of the identification of an individual with some character who does succeed. Who has not noticed the crowd of satellites gathered about the hero of a fight as if they by means of association might gain some of the glory? In books for boys and girls and in the moving pictures innumerable opportunities are offered for the gaining of desires which were otherwise impossible. At eleven or twelve years of age the young boy follows with breathless interest the escapades of John Silver, whose successes are the boy's successes, whose failures are his failures. With Altsheler's, Barbour's, or Tomlinson's heroes, boys at the age of ten to thirteen traverse mountains and rivers, shoot Indians, save the lives of a hundred persons, or win a football game. At a later age the youth identifies himself with the hero of a love story, he really becomes the hero, makes love, and wins the girl, and lives happily ever afterwards. He thus secures a fulfillment of his thwarted desires. Girls even more than boys, find ideal characters in fiction, with whom they identify themselves. This type of hero worship in many cases is a tremendous stimulation to the young boy's or girl's imagination. But when identification becomes a substitute for deeds as it does when the child turns from his attempts to be a real hero salving his pains and finding a surcease from his sorrows in living with some imagined hero, it becomes exceedingly dangerous, for the passage from a condition such as we have just mentioned to a condition in which the insane individual identifies herself as in one case with the Empress Louisa, wears yachting clothes, and lives the part, and believes that she is the real Empress, is not as abrupt as we had formerly believed.

Sour Grapes and its Opposite. The old, old story of the Fox and the Grapes is, of course, a fable, a tale with a moral; the moral being that we should not belittle the things we cannot attain. Now belittling the objects we are unable to obtain is called the sour-grape type of response. Ordinarily such action is an attempt to preserve one's self from a feeling of guilt, to keep aloft one's self-esteem, to prevent others from thinking little of us. A young child may desire an object very much but when he cannot get it he "didn't want it anyway." If marbles are the bone of contention he begins to tell how dirty those old marbles are, besides they are not so large as his, and not nearly so pretty. A high school boy strives with all his might to make the football team, but he is a little too light or too slow so that he is not included on a certain trip. At once the sour grapes reaction shows in his assertions that he didn't want to go on that trip anyway. And after all what is football? Merely a game which requires brute strength to play, and who cares for brute strength? The opposite sort, the Pollyanna attitude, arises in the acceptance of any object as belonging to you and then arguing that this is just what you wanted. It is the basis of complacency. Little children speak of *my* big brother, and *my* father, and of what *my* uncle John can do. Youths see nothing wrong with their possessions and make much of their blessings. Certain citizens can see nothing wrong with their town, considering it the "best town on earth." One young man on being teased a good deal about the lack of beauty in his girl friend replied that she was a good girl. In many or in all of these cases the individual retreats from an unpleasant reality by enlarging upon a partial fact.

Mental Hygiene

What can be done to prevent such an enormous waste of mental energy and consequent unhappiness? Now the cause of mental disturbances seems to be the psychological *tension produced* by either *present* or *imagined hostility* or *ridicule*. Not the organic inferiority, then, but the *feeling* of inferiority aroused thereby; not malpractice in the realm of sex but the *anxiety* aroused by a *feeling of guilt* and a fear of the loss of manly power—these are the *veræ causæ* of mental disturbances. What can be done to help?

Above all else the teacher can avoid the use of hostility and ridicule towards children whatever be the type of their actions. He or she can meet the difficulties arising with a sympathetic understanding, because he has studied the causes of maladjustments and realizes that the present maladjustments are quite similar to those that he has studied. If the case is unlike these studied the teacher knows that back of their curious behavior is some cause which can be discovered by sympathetic study. Moreover, pupils can be taught that ridicule is one of the meanest types of social control, that it engenders, at best, ill feeling and irritation, and, at the worst, hate and a desire to kill.

In the second place, every single child must be thought of as an interesting problem for individual study. Each has a different heredity, a different environment from every one else, and the habits resulting from these differences are not the same for any two individuals. The first step consists of a thorough physical examination and treatment, for while the physical difficulty may not cause the mental condition it is frequently a coöperating factor. Frequently the removal of physical difficulties causes to disappear the mental maladjustments. In the second place, one of the soundest principles of learning is the principle of substitution rather than of elimination of responses. Wholesome substitutions for almost any insistent urge may be discovered if we look far enough, and vigorous physical exercise may drain off much of the superabundant energy of young people.

The school as an institution may play a great rôle in providing adequately for individual differences so that each one may make visible progress in some direction. This means that the material of instruction is so graded from easy to hard that the child proceeds from one step to another with few conscious breaks in thought. The best present practice would have no failures but only progress at differential rates. The joy of successful accomplishment is one of the really great factors making for a healthy outlook on life.

The effect of retardation upon behavior problems is well illustrated by the study of the incidence of undesirable behavior appearing in 800 elementary school children in a modern school (Figure 45). The undesirable behavior ranged all the way from obscene notes, truancy, and stealing, through defiance to discipline, temper outbursts, to lying, cheating, and disinterest in school work.

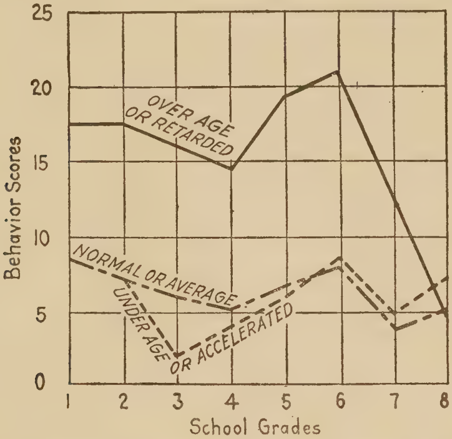

FIG. 45.—Relationship between behavior scores and age-grade status. The scores are so arranged that increasing behavior scores mean a greater amount of undesirable behavior. (Haggerty, 1925.)

It is clear from this graph that there is a direct relation between retardation in school and undesirable types of conduct. It is at least suggested that the tension caused by a feeling of ridicule incident to being retarded is reduced by these antisocial outbreaks. The teacher needs ever to be on the alert for failures of children to meet realities squarely. They must be taught to take the blame for their escapades, to own up to their derelictions. Compromise with reality must be clearly recognized. Too much daydreaming, too, needs investigating, for this is a sign that some emotional experience is blocking the proper reaction to the environment. Morbid anxiety is almost a sure sign of sex difficulties. In this case there is great need of a sympathetic individual who has the confidence of the child, a physician, a parent, perhaps the teacher himself if he can talk calmly about these matters. Someone must help the young person with his anxiety or else the difficulty may remain permanent. The emotional tension produced by a *feeling of guilt* because of sex difficulties needs to be reduced. This is best done by bringing to light the secret guilt and explaining it to the subject's satisfaction and then by helping him substitute some desirable response for the undesirable one.

Probably one of the best ways for the teacher to help a young person get rid of his feeling of inferiority and discouragement is to discover those qualities in which the subject can succeed, in which he can receive earned commendation. It matters not whether this trait be in a school subject or not, but something must be found in which the individual can succeed. Cases are on record in which there was a distinct transfer of interest from one of these functions legitimately praised to another of a school nature, and then to another, until the whole attitude of the school child towards himself and his work had undergone a change. Instance the case of Mildred getting the commendation of her associates by making pendants when she had so hopelessly failed in reading.

For young people generally, participation whole-heartedly in some type of wholesome athletics is one of the best reducers of tension that one can imagine. The child loses himself in his athletics. He becomes a member of a team, a devoted adherent to its success and failure. He turns his thoughts outward instead of inward, he learns about the desires and ambitions of others, he can bear thwarted desires because that is all in the game. Games of various types are unusually excellent opportunities, then, to develop social contacts. For boys, no type of recreational activity quite equals the Boy Scouts. This organization brings young people into social contacts in the best manner possible—the spirit of comradeship. Its very organization tends to give young boys a social outlook. Campfire Girls and other similar types of organizations have not been quite so effective as Boy Scouts, but if properly managed hold out almost as great promise. As important as anything else is the habit of trusting children, of developing within them a feeling of responsibility. Finally, we must never forget that right mental habits are more important even than reading or history, in the life of the individual.

Stuttering. A good example of an abnormal speech habit closely related to severe emotional experience is stuttering. Its causes are manifold: some cases appearing from either general organic weakness or special defects of the muscles of *articulation* or *vocalization;* others from the persistence of some *chance habit;* while still others arise because of some intense emotional experience such as fear or guilt. The ridicule from a sharp-tongued teacher may also increase stuttering. Furthermore, there are certain evidences that stuttering in at least many cases is caused by a feeling of *inferiority* which results in such self-consciousness that their ordinary channels of expression are blocked. Of the many evidences we shall quote only a few. Some children read in concert when they cannot read alone; others are able to talk freely to younger individuals or to those a little less distinguished. Changing from the use of the left hand to the use of the right in a normally left-handed person may enhance a feeling of awkwardness, a consequent feeling of inferiority and self-consciousness. Whatever the causes, the treatment holds out to us the most interest.

In general, the first step is a thorough physical examination and the elimination or alleviation of the sources of irritation. In the second place, the development of interest in language through singing and dramatics seems helpful. In the third place, the training in objective life interests through play and recreation help in lessening the anxiety about himself. Furthermore, it has been found that in many cases the causes of stuttering go far back into childhood. If the causes can be discovered and the whole process explained the treatment is sometimes successful. The following case is cited as an illustration of this method: In this case (cited by Aikins), a boy of 14 years, the stuttering was cured by uncovering for him the causes of his stuttering so that he could know that at least at present there was no fear contained in them. When this boy was four and one-half years old he had been attacked by a horrible mad dog from which his father had rescued him after considerable difficulty. The father killed the dog right there before the boy. The whole experience—being attacked, blood and all,—was a little too intense for the little boy, so that he began to stutter the next day. The horrible image arising from this experience arose to torment him day after day. When the cause of these apparitions was explained to him his stuttering began to improve.

Danger Signals

It may be well to list the danger signals of maladjustments which should give us pause:

Physical

Twitching and fidgeting [1]
Constant drumming with feet or fingers
Constant "making faces"
Stammering or stuttering and queer breathing

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[1] Most of these appear in one of the panels for teaching mental hygiene of childhood prepared by the National Child Welfare Association.

Biting finger nails continuously
Other nervous mannerisms
Lies awake at night
Tosses and turns each night
Dreams constantly
Has nightmares
Walks or talks in sleep
Often vomits

Conduct

Inner Experience	*Outer Manifestations*
1. Daydreaming	1. Withdraws, negative, loses interest, unsociable. May become careless of personal habits
2. Unduly interested in sex matters	2. (a) Exhibitionism, masturbation, writes indecent notes, morbid anxiety (b) May result in truancy, stealing, destroying, and other abnormal manifestations (c) Unusual cruelty
3. Feelings of inferiority	3. Spite Worry unduly Tries to be tough Easily embarrassed Highly sensitive May enjoy casting aspersions on work of others

	May bluster and talk loudly Pout Attempt suicide Extreme timidity Stuttering, other speech difficulties
4. Desire for abnormal excitement	4. Sets fire to property Temper outbursts Truancy Robbery Various escapades in opposition to moral code
5. Fear of consequences of acts because of ridicule, hostility, or indifference	5. Blames others Gives excuses continually Runs away from home or school Rationalizes, thereby saves his face Suspicious Abnormal lying

Summary

Maladjustment in young people is not only a cause of present unhappiness, but may eventuate in dire consequences lasting a lifetime. Poor adjustments to environment appear because of (a) predisposing causes or (b) exciting causes. The predisposing causes are frequently of an organic nature, the most important of which is the neuropathic taint or inherited nervous instability. The feeling of guilt or shame seems to be the most important exciting cause. Sex delinquencies, organ inferiority, overexcitement are genuine causes of maladjustments just when they arouse feelings of inferiority, a psychologic tension. The reduction of this tension is produced by daydreaming, compensation, rationalization, projection, identification, and by sour grapes and its converse. In each case we find an individual striving this way and that to save himself from ridicule or from hostility. The thing to be done is suggested in the treatment of the various means of escaping from reality. Most important of all is the early recognition of any type of compromise with reality and the making of such action extremely annoying while the meeting of reality in an honest way is always rewarded. Participation in athletic games and in social occasions of various sorts is helpful in aiding the individual gain healthy social interests. Above all else is ridicule to be avoided and all the conditions surrounding the child's maladjustment approached with a sympathetic understanding of the difficulties involved.

QUESTIONS AND EXERCISES

1. What is meant by the term, "Maladjusted Child"?
2. Distinguish carefully between *predisposing* and *exciting* causes. Illustrate each. Under which would you place (a) thyroid deficiency; (b) too much adrenal; (c) a succession of business reverses; (d) alcohol to the extent of inebriety; (e) softening of the brain.
3. Why is this such an important problem to the teacher?
4. Select one of the worst disciplinary cases that you can find. Look up carefully his family history, his home life, get him to talk to you about his present outlook on life. Can you explain his actions by means of any of the principles laid down in this chapter?
5. Distinguish between an extrovert and an introvert. What would be some of the characteristics of each?
6. Report, if you are willing to, one of your daydreams. Do you know the reason for it? Summarize the chief characteristics of daydreams. Just when do daydreams become dangerous?
7. How can an individual gain any satisfaction out of the suffering hero mechanism?

8. Describe precisely what is meant by "feelings of inferiority." What part does organic inferiority play? Under what conditions is organic inferiority apt to produce feelings of inferiority? Just what rôle does the school play?
9. How can the teacher help the pupil develop his best traits? Why is this development of the best trait of such importance?
10. What is meant by *projection?* What phase of this process is harmful to character?
11. Describe precisely the teachers' function in a mental hygiene program.
12. Plan out a mental hygiene program for a school. Emphasize particularly the function of the school, the home, and the community.
13. Use Haggerty's list (see bibliography) in investigating. Get a teacher of the fourth or fifth grade to keep a record of these various types of abnormal behavior for one week and report to class your results.
14. With his list of types in hand observe children on the playground for four days. Tabulate your results.

REFERENCES

Aikins, Austin. "Casting out a 'Stuttering Devil,'" *Journal Abnormal and Social Psychology*, Vol. XVIII, July and September, 1923.

Anderson, Lewis O. "Stuttering and Allied Disorders," *Comparative Psychology Monographs No. 1*, pp. 1–78, 1922–1923.

Bagby, English. *The Psychology of Personality*, 1928.

Burnham, W. H. *The Normal Mind*, 1924.

Ellis, M. B. *The Visiting Teacher in Rochester*, 1925.

Fletcher, J. M. "An Experimental Study of Stuttering," *American Journal of Psychology*, 1914, Vol. XXV, pp. 201–255.

Furfey, Paul H. *The Gang Age*, 1926.

Gates, A. I. *Psychology for Students of Education*, Chapter IX, 1923. Also *Elementary Psychology*, Chapter IX, 1925.

Green, G. H. *Psychoanalysis in the Class Room*, 1922.

Haggerty, W. E. "Incidence of Undesirable Behavior in Public School Children," *Journal of Educational Research*, 1925, Vol. *12*, pp. 102–122.

Hart, Bernard. *The Psychology of Insanity*, 1912.

Healey, William. *The Individual Delinquent*, 1924.

Healey, William. *Mental Conflicts and Misconduct*, 1917.

Mateer, Florence. *The Unstable Child*, 1924.

Morgan, John J. B. *The Psychology of the Unadjusted School Child*, 1924.

Morton, G. F. *Children's Fears*, 1925.

Pfister, Oskar. *Love in Children and Its Aberrations*, 1924.

Pressey, Sidney L., and Pressey, Luella C. *Mental Abnormality and Deficiency*, 1926.

Sayles, Mary B. *Three Problem Children*, 1925.

Sayles, Mary B. *The Problem Child in School*, 1925.

White, W. A. *Mental Hygiene of Childhood*, 1919.

White, W. A. "Nervous and Mental Hygiene Among Children in Present Day Life," in *The Child: His Nature and His Needs*, 1924.

Woodworth, R. S. *Dynamic Psychology*, Chap. VII, 1918.

Woolley, H. I., and Ferris, E. *Diagnosis and Treatment of Young School Failures*, 1923.

CHAPTER XV

PROBLEMS OF DISCIPLINE ARISING FROM THE BACKWARD AND RETARDED CHILDREN

The Misfits

Whenever there is great diversity among members of the same class in mastery of the material being studied or in their capacities for learning, difficulties in discipline are more likely to occur. The reason is, of course, that, because of such differences, the explanations of the lessons and the introduction of new material cannot be placed upon a level stimulating to all, since there are so many levels represented in the class. The level on which the recitation is pitched is usually about that of the class average. This procedure bores the bright and confuses the stupid. The former become restless at hearing carefully explained what they already know; the latter are apt to become stubborn and hopeless because they cannot understand what is going on. In both events serious discipline cases may appear.

The Backward and Feeble-minded

If we give an intelligence test to any large unselected group of children and plot their results they approach the form of normal probability curve. This is a smooth curve with no breaks or gaps (Figure 46).

Now it is the present custom to consider the lowest I.Q.'s as idiots, i. e., those to about 20. These individuals are grossly deficient in intelligence, that primary concern of learning. Imbeciles are those whose intelligence quotients range from 20–40; while morons vary from 40 to about 70. We have then:

I.Q.'s
idiots = 0–20
imbeciles = 20–40
morons = 40–70

These words are merely descriptive of a certain range of mental development. There is no intention to intimate that each of these groups is separated from the others by any sort of gap. Each glides almost imperceptibly into the other so that a high grade idiot may be mistaken for a low grade imbecile or a high grade imbecile for a low grade moron, or a high grade moron for a normal individual. Furthermore, on almost any type of mental traits in which idiots and imbeciles are measured, some idiots will overlap the lowest imbeciles.

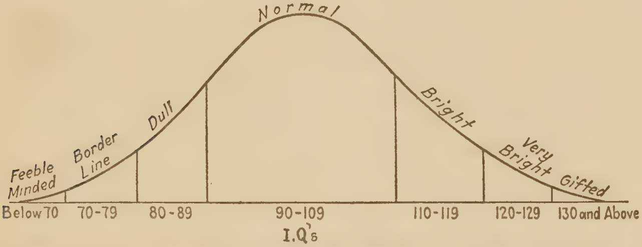

FIG. 46.—The normal probability curve to which measures of intelligence conform when the group measured is a random one. The numbers along the base lines are intelligence quotients; the areas under the curves represent the percentage at each I.Q. level. The feeble-minded could be further divided into (a) idiots, I.Q.'s 0–19; imbeciles, I.Q.'s 20–39; and (c) morons, I.Q.'s 40–69.

This precise way of referring to those feeble in mind has been made possible by the progress in intelligence testing. Intelligence tests have aided in detecting mental weakness and particularly have they been helpful in discovering mental weakness in the levels of intelligence very near the normal. But there are at least three other ways for determining whether or not an individual is feeble-minded.

The *Socio-Economic* Method of determining feeble-minded has been broadly used. Among many of the feeble-minded there frequently appear those who are able to make a living because they are strong physically and steady emotionally. They, with a little advice, are thus able to make their way in a normal environment. Some would use this criterion of making a living, the final one for feeble-mindedness. Thus the Royal Commission of Great Britain in 1904 defined mental deficiency as follows: "A feeble-minded person is one who is capable of earning a living under favorable circumstances, but is incapable, from mental defect existing from birth, or from an early age, (a) of competing on equal terms with his normal fellows; or (b) of managing himself and his affairs with ordinary prudence." [1]

While every one admits the good sense displayed in this definition the difficulty comes when the effort is made to apply it. For what could be meant by "Competing on equal terms with his normal fellows"? Are one's normal fellows, those in a hustling city environment such as Chicago or New York, or rather are they to be taken from a more simple farming community where many chores to be performed are on the level of even the feeble-minded? By this criterion whether or not a person was feeble-minded might not depend on him, but upon his environment. Furthermore, managing one's self and affairs "with ordinary prudence" is again hard to apply in the particular case since the terms might be defined quite differently by a mountaineer and by a city dweller.

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[1] Hollingworth, L. S. *The Psychology of Subnormal Children*, p. 43, 1920.

The *medical* is another method of identifying the feeble-minded. Physicians accustomed to treat disease have usually referred the difficulties of the mind to a physical cause. Perhaps the best known of these is the following: "(Amentia) A state of restricted potentiality for, or arrest of, cerebral development, in consequence of which the person affected is incapable at maturity of so adapting himself to his environment or to the requirements of the community as to maintain existence independently of external support." [1] Here again, the definition is excellent, but it is impossible to apply it accurately in the particular case. Furthermore, the development of the neurones in the cortex can be discovered only after death, while what we want is a test to distinguish among individuals and to aid in classifying them for purposes of educating them while they are alive.

The *pedagogical criterion* of defining a child as being feeble-minded if he is three years retarded, fails to distinguish between retardation as caused by sickness and other physical disabilities, such as blindness or deafness, and that caused by feeble-mindedness.

Because of the objections to the socio-economic, medical, and pedagogical criteria there is a general tendency towards the acceptance of the *psychological* one. This defines feeble-mindedness as a lack of intelligence by using the I.Q. of 70 as the arbitrary dividing line. The only real limitation to this method is the fact that some individuals with an I.Q. of 70 and below who have a calm temperament are able to maintain themselves without external support. These, most students are unwilling to call feeble-minded, even though they possess I.Q.'s below 70.

The lowest grades of the feeble-minded, the idiot and lower grade imbeciles, never come into the schools. The higher grade of imbeciles, the morons and the retarded come to the schools in large numbers. They, failing to advance in an environment manifestly unsuited to them, are usually retarded until they get too large for their desks or until the teacher becomes weary in trying to instruct them. They are then promoted, although usually they have not completed satisfactorily the work of that grade. These backward and feeble-minded children thus form one of the most difficult problems in all the school situation.

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[1] Tregold, A. F. *Mental Deficiency*, p. 8, 1914.

On page 425 may be seen the graph which shows the close relation between retardation and behavior difficulties. In all the school grades save only the eighth the curve indicating poor behavior of the retarded stood high above those for the normal and the advanced. Not infrequently the boy or girl whose presence is an exciting influence in school is one who is feeble in mind but who compensates for this weakness as well as may be with attempts to get ahead in other directions which, while not so vicious in themselves, may involve the child in matters of serious disciplinary import.

Physical and Mental Traits of the Feeble-minded

Physically, morons, imbeciles, and idiots are more like normal individuals than they are mentally. In height and weight there is much overlapping. In general the morons are most like normals; the imbeciles less like them; and the idiots least. In cranial measurements it is reported that 30 per cent of institutional cases (Hollingworth) fall within the normal limits. In vital capacity (measured by the amount of air exhaled from the lungs in one breath) the differences are somewhat greater in favor of the normals. Unfortunately, the efficiency of this measurement depends somewhat upon intelligence as well as upon lung capacity. Similar results are found in the tests for the strength of the grip of girls when the dynamometer is used. This piece of apparatus consists of an instrument to measure the grip of the hand by means of compressing a spring. The successful following out of the instructions of this test depends upon intelligence to a certain extent. Frequently experimenters have felt that the difference between the feeble-minded and the normal was not due so much to lack of strength as much as to the lack of the mental capacity to coördinate muscular action.

In general, feeble-minded boys and girls are more successful in manual activities than in intellectual activities. They are able to do woodwork, make baskets, and in general to do simple neuromuscular work which does not depend too much upon the higher types of motor coördination.

Mental Characteristics. If feeble-minded and normal are most alike in performing simple motor habits they are most unlike in thinking abstractly. In emotional experiences there seems to be a middle ground. Idiots display few emotions. Imbeciles and morons approach normality more closely in their emotional responses. There is, however, no high correlation between the degree of emotionality and the amount of intelligence. The expression of the instinctive and emotional urges in an unsocial manner furnishes good evidence of their presence. Investigators report that theft is the most common type of delinquency, truancy comes next, then come sex, incorrigibility, and disorderly conduct (Hollingworth). It would seem in many cases that derelictions appear not because their impulses are stronger than normal but because there is less inhibition to action.

Learning of Feeble-minded. Whenever normal children have been compared in learning with feeble-minded of the same chronological age the results have turned out decisively in favor of the normal group. The curve of the mentally defective has shown only small ascents while the curve of normal children of the same age frequently rises very rapidly.

The differences between children of the same mental age are not so great. Suppose we should take a child of chronological age 15 and mental age 7 and a child of 7 years with a mental age of 7, how would they differ? Of course the older child would be much larger and stronger. He might also have the changed emotional disposition appearing with the onset of puberty. He would know more since he had remained longer on the same level, i. e., there are a large number of simple bits of information and motor habits which may be attained at a six year old level. These acquisitions would tend to make the two individuals of equal mental age somewhat different. But when the learning of new material was approached the differences would be small indeed.

One investigator (Woodrow) compared two groups of equivalent mental ages but differing widely in chronological ages in learning a simple sensori-motor habit. This consisted of sorting gun wads covered with printed stars, circles, triangles, squares, and crosses, into their appropriate piles. He found no essential differences between the normal and feeble-minded group in scores on this test. Moreover, when the amount of transfer from the thirteen days of practice to sorting sticks of different lengths, canceling letters and geometrical figures and such like, there was no more transfer effect among normal children than among the feeble-minded of the same mental age. His general conclusions were that as far as learning capacity and ability to transfer were concerned, children of the same mental age were the same whatever might be their chronological age.

Quite different in results was another experiment. In this one the growth of feeble-minded children for one year was compared with normal children of the same mental age in tests of reading, writing, spelling, composition, arithmetic, word knowledge, etc. The results were definitely in favor of the normal children in practically every instant. But Miss Murdock, the experimenter, failed to recognize the fact that the feeble-minded had remained at about the same level, as Hollingworth points out, while the normal children had grown a whole year mentally. It was most probably this increased mental growth which enabled the normal children to surpass the feeble-minded. These two studies are then mutually supplementary rather than antagonistic.

If this principle of the same learning capacity at the same mental age is true, and the evidence certainly points in that direction, it presents a very helpful suggestion for the education of the feeble-minded. The problem now becomes: first a determination of the mental level of the feeble-minded, second a selection of materials suitable for that level of mental development, and thirdly a selection from this material of the type of work suitable for the social outlook and present interests of the feeble-minded. In brief it gives us a starting point from which progress may be made.

This principle aids further in our understanding and treatment of the backward. We now know that physical size is not the best criterion for homogeneous grouping nor even chronological age but rather mental age. When, therefore, large but stupid children are promoted, disastrous consequences may follow because the child cannot understand nor learn the material of the grade. He becomes confused, struggles gamely for a while, and then surrenders, no longer even attempting to conquer the work of the grade. He may become morose, ugly tempered, or he may strive to make fun of the whole business. In both cases he becomes a danger to the class morale and soon a problem child. Furthermore, since he does remain on a mental level so long his body has grown larger, his interests have changed, and he is a misfit. He cannot do the work of children of his own size and grade, he scorns the work of children of his own mental age or else assumes a beaten, submissive attitude. The children also make fun of him and we know from the last chapter the pernicious effect of ridicule. In short, a special class is the only possible way out of the difficulty.

In these special classes the work is adapted to the level of intelligence which is to be dealt with. The classes are small (15 to 18) and the instruction tends to be individual whenever that is necessary. The material of instruction is selected from types of activity in which the backward are more apt to succeed. Work in wood, clay, cloth, and raffia has proven very adaptable to these backward groups. These individuals live largely in the sensori-motor level and the learning must be performed on this level. The more advanced can learn to write and read and to work simple arithmetic, but in most cases little abstract material is useful. Probably more than in any other classes is it necessary to help these individuals form right habits of conduct. There needs to be careful drill on the formation of connections between specific situations and just as specific responses. Thus, in the *situation* "Candy lying around loose on the counter," the *response* is "Don't take it."

In case after case we find principals and teachers reporting an entirely different attitude of pupils when they get to work in these special classes. They, who have been getting further and further behind, completely befuddled by what is going on, are made happy in their success with work adapted to their levels of intelligence. Many who have been truants on several occasions are no longer interested in running away from school. It is thus possible to give to many children of low grade intelligence those specific habits of conduct which will enable them to succeed fairly well with a small amount of sympathetic direction.

The Gifted

The need for special provision for the educational treatment of the feeble-minded has preceded by several years the adequate provisions for the education of the gifted. The reason for this is not far to seek. Feeble-minded children, on account of their rank stupidity, their inability to profit by the ordinary instruction offered, have made such nuisances of themselves that they have forced the recognition of their presence upon the teachers. Not so the gifted. These more favored ones have helped the teacher carry the burden of her teaching by occupying the floor with the recitation of the facts which they have gleaned. Sometimes the teacher has seen a responsive gleam in their eyes which did not appear in those of the others and has for these reasons kept them in a grade when they should have been promoted immediately.

From the standpoint of instruction these two or three bright ones have influenced the teacher unduly to pitch her recitation on a higher level, thus obscuring the issue for those of mediocre ability. We have already commented on how this average level instruction confuses those feeble in mind and causes them to lose all interest in school and to become disciplinary problems. It, of course, has not this effect upon the gifted but by teaching at a level below their capacities the explanations and repetitions seem entirely useless to them, they get into mischief, not because they have formed vicious habits, but because they are idle. They report that they are utterly bored by the recitation, that they felt like screaming when the teacher went over that problem for the third time. Furthermore, by keeping them at work on material too easy for them they form the habit of taking things too easily, of accepting honors as a matter of course, of never feeling the dynamic impulsion to stretch themselves to the limit.

The Discovery of the Gifted. Teachers and parents from the beginning of time must have realized the great amount of differences existing among their children. Brilliant ones certainly have delighted teachers from the beginning. Here and there we find a record of children so brilliant in intellect that the attention of all was called to it.

We hear, for example, of Christian Heinrich Heinekin who at ten months old learned the names of things on pictures, and who even before the age of twelve months had learned by heart many of the best stories of the Old Testament. At the age of four years this child had accomplished about as much as the ordinary child of eight years, being able to perform the four fundamental operations in arithmetic and to read. He had learned some French and some German, and knew many important facts of history and geography. But he was sickly and died at the age of four years and four months. More recently such names as Winifred Stoner, and Norbert Wilner have become popular. Furthermore, the biographies of great men have shown in many instances, unusual brilliance in childhood. But these young geniuses occur somewhat sporadically and are undoubtedly in many cases far more exceptional than what we mean here by the gifted.

The discovery of the gifted for purposes of a more fitting educational treatment has awaited the advent of the intelligence test. These measures have given a precise way of designating the gifted. Terman has said that those whose I.Q.'s ranged from 110–120 should be designated as being of *superior intelligence;* from 120–140 as of *very superior intelligence;* and that those above 140 should be called "*near*" *genius* or *genius.* More recently he has used the descriptive term "gifted" as being synonymous with genius.[1]

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[1] Terman, L. M., et alia. *Genetic Studies of Genius*, Vol. I, 1925. In the discussions within the book he almost always speaks of the Gifted. The lowest I.Q. considered is 140.

By using the word "gifted" to include those above 120 I.Q. we can subsume under one word all those who probably need a different kind of treatment from that provided in the average school. Furthermore, many of the investigators have used 120 as the lower limit when investigating the characteristic traits of "superiors." The word "gifted" then in this text will refer to those individuals whose I.Q.'s are above 120. It will be remembered that there are no gaps between the gifted and the normals any more than there are between the feeble-minded and the normals. Then, too, just as there are different degrees of the feeble-minded there would be different grades of the gifted such as very superior, near genius, genius, corresponding at the lower end of the curve to idiot, imbecile, and moron. The gifted would ordinarily constitute about 2 or 3 per cent of the total school population.

a. *Physical Traits of the Gifted.* The physical characteristics of the gifted vary but little from those of the normal. Children above 135 I.Q. were found in one investigation (Hollingworth and Monahan) to be able to tap more effectively, to have superior body weight, and to have stronger grip than normal individuals of the same age, sex, and race. They are able to broad-jump as well, too, but are inferior in the ability to chin themselves. They attribute the inferior chinning capacity of the gifted to heavier body weight. In the study of 643 gifted children (all I.Q.'s above 140) Baldwin reported that "The gifted California children as a group are above the best standards for American born children in physical growth status for average standing height and weight. They also excel in average standing height and weight other groups of California children studied by Barnes, Boas, and Faber." [1] As a whole children of unusual mental capacity are physically superior to normal groups used as comparison in these studies. There are of course rather striking exceptions. One writer (Gillingham) reports that among the gifted studied by her there were many poor in muscular control, producing especially poor penmanship. Others have reported similar cases of physical weakness among the gifted.

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[1] Terman, L. M., et alia. Op. cit., 1925, Vol. I, p. 169.

b. *Mental Traits of the Gifted.* Intellectual capacity has been taken as the deciding criterion of the gifted. It is then not unreasonable to expect the gifted to surpass the normal whenever the function measured is intellectual capacity or intelligence. Then, too, whenever the work to be done depends upon the functioning of this capacity are the gifted superior. One investigator (Root) finds that the superior group surpassed the norm in both the Binet and in other psychological tests. The selected group, too, were unusually pertinacious, performed their work in a superior manner, and criticized their work more severely. Some have observed a greater intellectual spontaneity, and a wider interest in all sorts of life's activities.

The gifted are more successful in school work. When the gifted children of California were tested very efficiently with the Stanford-Achievement Test they scored about 40 per cent above the norms for their chronological ages. We would recall here that the I.Q.'s of this group were 140 and above, which fact accounts for their unusual achievement in their subjects of instruction. In other studies the gifted have always been superior in their school work but not so far ahead as was this group. One of the causes for their greater success is their interest in (a) their school subjects and (b), in reading in general. These facts might merely be a symptom rather than a cause of their success, for the more abstract school subjects better fitted to the intellectual level of the gifted may call out a greater interest. At any rate the reports of the gifted indicate that they are more interested in their school subjects, a fact which the following table shows:

TABLE XLVI

INTERESTS OF AVERAGE AND SUPERIOR CHILDREN IN THEIR SUBJECTS OF INSTRUCTION

(Adapted from Yates, 1922, p. 50)

	Percentage of Those Taking Unusually Interested	
	Superior	*Control*
Science	71	21
History and Economics	52	32
English	48	24
Mathematics	28	12
Drawing	50	85
Music	31	33
Languages	17	23
Commercial Work	50	50
Manual Work	14	56

This table indicates the much greater interest of the superior group in science, history, English, and mathematics; about the same degree of interest as the normal in music, language, and commercial work, and a much greater interest of the control group in manual work and drawing. The subjects requiring the more difficult thought processes are much more likely to be appreciated by the gifted than by the control group and since this type of work constitutes the vast majority of school work the inference is clear that the gifted show much greater interest in their school studies. The findings of this study have been corroborated in other studies,[1] and can be accepted as a fact.

Finally, gifted boys and girls are more interested in reading in general than are average children. They read far more than the average. Parents estimate that gifted children read about six hours a week at age 7, and twelve hours at age 13. It has been further estimated that the average gifted child of 7 years reads more than the average of normal children up to age 15.[1]

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[1] Terman, L. M. Op. cit., 1925.

Does this unusual interest in books tend to develop individuals of a bookish nature who do not play games nor[2] show any interest in the social side of life? Investigations show that the control group and the gifted group participate equally in the number of plays and games but that the gifted tend to be more solitary in their plays, like reading better, and tend to avoid certain types of vigorous physical play.

These findings just quoted agree with Terman: "The gifted children show measurably greater interest than the control in activities that require thinking and that are mildly social and quiet. They show slightly less preference than do the control group for competitive games."[3]

In several other types of traits the gifted are superior. In tests of character in which the individual had an opportunity to cheat and lie, and accept undeserved credit the gifted were very superior to the control groups. In their judgments of moral situations the gifted seem to be five or six years ahead of the control. Estimates of both teachers and parents on personality traits show that the gifted are of equal or ahead of the normal group in all of the traits estimated. The gifted are definitely superior in self-confidence, sense of humor, desire to excel, truthfulness, desire to know, originality, common sense, and in general intelligence. To sum up: the gifted are a great deal ahead in intellectual and volitional traits, somewhat ahead in emotional, moral, and physical, and only slightly ahead in social traits. The superiority of the gifted, then, is a general and not a particular one.

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[1] Terman, L. M., et alia. Op. cit., Vol. I, p. 454.

[2] Witty, Paul S., and Lehman, Harvey G. *The Play Behavior of Fifty Gifted Children.* See Bibliography.

[3] Op. cit., Vol. I, pp. 17, 18, 437.

There have been at least four provisions made for purposes of meeting the conditions produced by having a large number of brilliant minds in the ordinary school grade: (1) a more rapid promotion, (2) the enrichment of the program, (3) special classes, and (4) individualized instruction such as the Winnetka or the Dalton plan. Rapid promotion has the disadvantage of placing certain pupils among others much ahead in physiological maturity. This procedure brings about an unfortunate condition. Unfortunate because there is very little opportunity for the gifted to obtain desirable social development. The second, the enrichment of the program, offers a fine opportunity for success but has not been worked out sufficiently well to prevent a child from advancing in height while he is gaining in breadth. The third plan, homogeneous grouping, unless carefully managed may overemphasize to the children concerned the fact that they are the brightest and may thereby create in them a tendency towards an increased egocentricity. Probably some such plan as the one used in Winnetka might gain the desired end and at the same time provide for material sufficiently difficult to bring out the best work of which the gifted are capable.

Summary

The feeble-minded and the gifted form a large per cent of the misfits in the modern school. The extremes require special provisions to insure to each and all an equality of opportunity.

The feeble-minded are discovered best by mental tests. They may be divided into idiots, imbeciles, and morons. Their traits do not constitute separate qualities but are continuous from the central tendency of all the children.

They are best educated in separate classes, rather than in the ordinary classes of the school. The type of training varies largely with the grade of intelligence possessed by each but leans towards the concrete and manumental. The gifted also need special consideration either in provision for special classes or in enriched curriculum or else in opportunity for individual advancement. They are usually more healthy and of somewhat finer physiques than the normal. They surpass the normal groups most in the ability to think abstractly and least in physical work. In general, they are intellectually more curious, like their school subjects better, and read more than normals. They seen to be gifted both in mind and in body.

QUESTIONS AND EXERCISES

1. Why should not high-grade imbeciles be taught with normal children?
2. Explain precisely why disciplinary cases may appear both among the backward and among the gifted.
3. Draw the normal curve of distribution and indicate the divisions which we make on the basis of intelligence.
4. What advantages and what disadvantages has the psychological method of discovering the feeble-minded over the socio-economic, and the medical?
5. If possible visit a special class for the feeble-minded or backward. Make careful observations on (a) the type of material used in instruction, (b) the relation between chronological age and the level of intelligence, (c) the sorts of questions asked and (d) the general spontaneity of the pupils.
6. What is meant by saying that mental traits are continuous?
7. In what are imbeciles most like normals? Least like normals? What suggestions for education?
8. What type of curriculum suits the backward best? Plan out a curriculum for educating a feeble-minded girl of twelve with an I.Q. of 50.

9. How are children of the same M.A. with different chronological age different? How are they alike? What suggestions for education?
10. What effect has grouping of children according to their intelligence levels and the fitting of proper educational procedures to them, had on the discipline of the backward?
11. Who are the gifted? How are they discovered?
12. What habits of study, and outlooks on life may be developed by a failure to recognize their brilliance?
13. Which is more important, (a) the education of the masses or (b) the education of the leaders? Why? See Bagley: *Democracy and the I.Q.*
14. Describe the physical characteristics of the gifted. Do these studies seem true according to your experience?
15. What are the intellectual and moral traits of the gifted?
16. What studies do the gifted like best? Least? Why?

REFERENCES

The Feeble-minded

Baldwin, B. T. "The Learning of the Delinquent Adolescent Girls as Shown by a Substitution Test," *Journal of Educational Psychology*, 1913, Vol. *4*, pp. 317–332.

Goddard, H. H. *Feeblemindedness, Its Cause and Consequences*, 1914.

Goddard, H. H. *School Training of Defective Children*, 1914.

Hollingworth, L. S. *The Psychology of Subnormal Children*, 1920.

Murdock, K. "Rate of the Improvement of the Feebleminded as Shown by Standardized Educational Tests," *Journal of Applied Psychology*, 1918, Vol. *2*, pp. 243–249.

Pintner, Rudolph. *Intelligence Testing*, Chap. VIII, 1923.

Terman, L. M. *The Intelligence of School Children*. Chap. VIII, 1920.

Tredgold, A. F. *Mental Deficiency*, 1914.

Wallin, J. E. Wallace. *The Education of Handicapped Children*. Chaps. VII and VIII, 1924.

Woodrow, Herbert. "Practice and Transference in Normal and Feeble-minded Children," *Journal of Educational Psychology*, 1917, Vol. *8*, pp. 85–96, 151–165.

The Gifted

Almack, John C., and Almack, J. L. "Administrative Problems Connected with Gifted Children." *Educational Administration and Supervision*, 1922, Vol. *8*, pp. 129–136.

Cleveland, Elizabeth. "Some Further Studies of Gifted Children," *Journal of Educational Research*, 1921, Vol. *4*, pp. 195–199.

Cleveland, Elizabeth. "Detroit's Experiment with Gifted Children," *School and Society*, 1920, Vol. *12*, pp. 179–183.

Coy, Genevieve L. "The Mentality of the Gifted Child," *Journal of Applied Psychology*, 1918, Vol. *2*, pp. 299–307.

Garrison, C. G., Burke, Agnes, and Hollingworth, L. S. "The Psychology of a Prodigious Child," *Journal of Applied Psychology*, 1917, Vol. *1*, pp. 101–110.

Gillingham, Anna. "The Bright Child and the School," *Journal of Educational Psychology*, 1919, Vol. *10*, pp. 237–252.

Gillingham, Anna. "Superior Children—Their School Progress," *Journal of Educational Psychology*, 1920, Vol. *11*, pp. 327–347.

Henry, T. S. "Classroom Problems in the Education of Gifted Children," *Nineteenth Yearbook*, Part II, of the National Society for the Study of Education, 1920.

Hollingworth, L. S., and Monohan, Jane E. "Tapping Rate of Children Who Test Above 135 I.Q. (Stanford-Binet)," *Journal of Educational Psychology*, 1926, Vol. *17*, pp. 505–518.

Hollingworth, L. S., and Monohan, Jane E. "Neuro-Muscular Capacity of Children Who Test Above 135 I.Q. (Stanford-Binet)," *Journal of Educational Psychology*, 1927, Vol. *18*, pp. 88–96.

Hollingworth, L. S. "Subsequent History of E———: Five Years After the Initial Report," *Journal of Applied Psychology*, 1922, Vol. *6*, pp. 205–210.

Pintner. Rudolph, *Intelligence Testing*. Chap. IX, 1923.

Race, H. V. "A Study of a Class of Superior Intelligence," *Journal of Educational Psychology*, 1918, Vol. *9*, pp. 91–98.

Root, W. T. "A Socio-Psychological Study of Fifty-Three Super-Normal Children," *Psychological Monographs*, Vol. XXIX, No. 133, 1921.

Specht, L. F. "A Terman Class in Public School. Number 64 Manhattan." *School and Society*, 1919, Vol. *9*, pp. 393–398.

Terman, L. M. *Genetic Studies of Genius*, Vol. I, 1925.

Terman, L. M. *Intelligence of School Children.* Chaps. X and XI, 1920.

Whipple, G. M. *Classes for Gifted Children*, 1919.

Witty, Paul A., and Lehman, Harvey C. "The Play Behavior of Fifty Gifted Children," *Journal of Educational Psychology*, 1927, Vol. *18*, pp. 259–265.

Yates, Dorothy Hazeltine. "A Study of Some High School Seniors of Superior Intelligence," *Journal Educational Research Monographs*, No. 2, 1922.

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